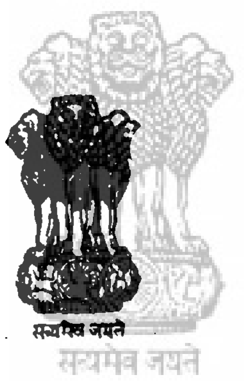
REPORT

of the

EXPERT GROUP ON CROPPING PATTERN



GOVERNMENT OF INDIA
MINISTRY OF AGRICULTURE
DEPARTMENT OF AGRICULTURE & COOPERATION

PREFACE

In February, 1985 the Department of Agriculture and Cooperation, Government of India, constituted an Expert Group to study cropping patterns in the country with a view to examine their economic rationality, lay down guidelines for determining socially optimum cropping patterns for different regions and identify the technological/resource gaps for achieving the optimal patterns.

In their choice of combining crop enterprises the farmers in the country are found to be quite rational in the sense that they try to maximize their net income under given resource and technology constraints. However, there could be a divergence between the actual cropping pattern and the socially desirable cropping pattern. But since farmers readily respond to the opportunities provided to them through various price and non-price signals, it should be possible to minimise this divergence between individual decisions and social requirements through appropriate policy interventions. The extent to which a shift towards desired cropping patterns can be induced through technological improvements, appropriate water management practices, a suitable package of price policy, marketing support and spatially oriented input delivery systems has been examined by the Expert Group in this Report.

The Directorate of Economics and Statistics, Ministry of Agriculture provided the necessary support for the work of the Expert Group. I would like to place on record my deep appreciation of the active interest shown by Dr. G. R. Saini, the Economic and Statistical Adviser, by readily extending the necessary facilities. The main responsibility for organizing the work of the Expert Group was undertaken by Dr. M. S. Bhatia, its Member-Secretary, who also did considerable amount of statistical work and analysis, besides preparing the draft report. Shri M. L. Manrai, Deputy Economic and Statistical Adviser put in substantial amount of work for the preparation of final draft during the period when the Member-Secretary proceeded on training to U.S.A. The technical and secretarial support was rendered by S/Shri Mulayam Singh and M. P. Vohra, Research Investigators and S/Shri S. C. Gupta and Jai Prakash, Stenogrphers. I would like to thank all of them for the assistance rendered.

सत्यमेव जयते

C. H. HANUMANTHA RAO
Chairman

17th September, **1987**

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CHAPTER I

INTRODUCTION

1.1 THIS Group was set up, with the approval of the then Minister of Agriculture & Rural Development, on 19th February, 1985 to examine the economic rational of the present cropping patterns and lay down guidelines for determining socially optimum cropping patterns in different regions of the country, based on agro-climatic and other relevant factors like existing infrastructure and the overall objectives of maximising agricultural productivity. A copy of the Government of India notification indicating the composition and terms of reference of the Group is at Annexure 'A'.

1.2 The Group submitted its Interim Report (vide Appendix) in September, 1985 which was forwarded to the Prime Minister's Office and the Cabinet Secretariat in December, 1986. The major findings of the Group in that Report were :

(a) Indian farmer responded positively to improvements in technology and market signals. He has achieved high levels of efficiency in resource allocations under given technological possibilities and factor product price relationships.

(b) This was reflected in the fact that two-thirds of the area of 22 M. ha. brought under irrigation between 1960-61 and 1980-81 was accounted for by the more remunerative foodgrain crops like wheat and rice, the share of wheat alone being 47.5 per cent.

(c) The share of wheat in gross-cropped area improved from 8.5 per cent in 1960-61 to 13.6 per cent by 1983-84 while that of rice remained constant at 23 per cent. On the other hand, the rate of area growth under the less remunerative coarse cereals declined. Among non-food crops, more remunerative crops like sugarcane, potato, rapeseed and mustard recorded impressive growth rates.

(d) Rate of growth of production of wheat was more than the pace at which the demand for it grew while in the case of rice both demand and production growth kept pace. On the other hand, production growth of pulses, oilseeds and sugarcane lagged behind the growth rate in demand.

(e) While optimal crop patterns could be identified on agro-climatic considerations and encouraged by suitable policy package of price and market support, extension back up, improved technology *etc.*, the farmer as an ultimate decision-maker would choose the crops he would like to cultivate.

1.3 The Group's tenure initially was for six months. However, on account of the volume of work involved in arriving at its findings and recommendations, the tenure of the Group was extended upto May, 1987.

1.4 We availed the services of a Consultant for six months from April, 1986. We also commissioned a study on the impact of water management on cropping patterns in eleven selected irrigation command areas, following a decision taken in a meeting of State Irrigation Secretaries convened by us in April, 1986. This was in the nature of quick empirical study carried out by the Operations Research Group (ORG), Baroda, between May and July, 1986. The ORG was kind enough to undertake further analytical work on their study in the light of our requirements.

1.5 Annexure 'B' gives the dates on which the Group held its various meetings and also the calendar of events related to its functioning. The Group held its last meeting on 15th May, 1987 to consider the first draft report prepared by its Member-Secretary. A Drafting Committee consisting of the Chairman, Dr. G. S. Bhalla, Dr. Y. K. Alagh, and Member-Secretary was appointed to finalise the report in the light of discussions in that meeting.

1.6 We have examined critically the past trends in changes in the cropping patterns at the all-India level over the period 1950-51 to 1983-84 both on an overall basis and separately for irrigated and unirrigated areas. We have also tried to analyse the influence of major factors on the cropping patterns *viz.*, relative economics of cultivation of various competing crops, irrigation, price policy and technology. The possible impact of these factors on the cropping patterns at the all-India level in the course of next 15 years has also been studied. In Chapter VII of the Report we have projected a scenario on socially optimal cropping patterns at the turn of the century based on possible projetions of demand and supply of principal agricultural commodities.

1.7 As mentioned in our interim report, farmers in India are quite rational in their choice and combination of crop enterprises given the resources and technology available to them. This fact is already reflected in trends and shifts which have taken place in cropping patterns, particularly after the green revolution. No instrument is available to the State for dictating to the farmers the cropping patterns they should adopt. Nor would it be desirable to impose such decisions on the farmers, as the information on location-specific agro-climatic factors, input-output relationships *etc.*, available to the State in a vast country like India is necessarily limited. However, a shift towards desired cropping patterns can be induced through technological improvements in the crops, the production of which is sought to be increased, and by a suitable package of price policy, marketing support and spatially oriented input delivery systems.

1.8 In this report we have attempted to examine the directions in which shifts in cropping pattern at the all-India level would be desirable or necessary till the turn of the century and the various measures which could induce these shifts. A summary of our recommendations is given in Chapter VIII.

1.9 Cropping patterns are, however, location-specific and are the result of a complex of interacting factors, physical, economic and infrastructural. The agro-climatic and soil characteristics of a region primarily determine the crops which can be grown. The available technology in respect of various crops combined with extension, price and marketing support play a major role in influencing the choice of crop combinations by the farmers. Since this Report deals with the question at the macro-level, it can give only broad indicative guidelines as to the measures which can induce desired shifts in cropping patterns. We would strongly urge that similar studies at the level of agro-climatic regions be undertaken.

1.10 A number of studies have been undertaken to regionalise the country into agro-climatic zones. The National Commission on Agriculture demarcated the country into highly disaggregated agro-climatic regions (vide Volume 4 of their report on climate and agriculture). Dr. A. Mitra in his work on 'Levels of Regional Development in India' (1964) divided the country into 7 natural regions, 31 sub-regions and 89 divisions. Planning Commission in 1964 developed the concept of resource development regions and assembled data on physical conditions, topography, soils, geological formations, rainfall, cropping patterns, development of irrigation and mineral resources for each district of the country. On the basis of these data the country was divided into 14 resource development regions and the Island economies were listed as the 15th region. Dr. P. Sengupta and Dr. Galina S. Dasyuk in their study in 1968 divided the country into homogenous climatic regions classified as macro regions. Agricultural regions in Meso form were the physical divisions of natural regions and those in micro form were crop combination regions. This study divided the country into four macro agricultural regions, 11 Meso regions and 60 micro regions. Cropping pattern possibilities are the outcome of such agro-climatic factors as soil, rainfall, irrigation characteristics *etc.*, with the actual crop set chosen depending on relative profitability considerations.

ANNEXURE 'A'

No. 2(1)/MEW/85-ES

Government of India

Ministry of Agriculture & Rural Development
Department of Agriculture & Cooperation

New Delhi, the 19th Feb., 1985

OFFICE MEMORANDUM

SUBJECT : *Setting up an Expert Group for the Study of Cropping Pattern*

In pursuance to the recommendations made by the Committee of Secretaries at its meeting held on 12th October, 1984 and with the approval of Minister for Agriculture and Rural Development, it has been decided to constitute an Expert Group consisting of the following members :

Chairman

1. Dr. C. H. Hanumantha Rao,
   Member,
   Planning Commission,
   Yojana Bhavan, New Delhi.

Members

2. Dr. Y. K. Alagh,
   Chairman,
   Bureau of Industrial Costs & Prices.
3. Professor G. S. Bhalla,
   Chairman,
   Agricultural Prices Commission.
4. Dr. K. Kanungo,
   Adviser, Planning Commission.
5. Shri N. R. Banerji,
   Joint Secretary (Sugar),
   Department of Food.
6. Dr. M. V. Rao,
   Dy. Dir. Gen. (Crops),
   I.C.A.R.
7. Dr. G. R. Saini,
   Economist,
   Directorate of Economics & Statistics.
8. Dr. A. N. Singh,
   Joint Commissioner (CC),
   Department of Agriculture &
   Cooperation.

Member-Secretary

9. Dr. M. S. Bhatia,
   Special Adviser (IS & EA),
   Directorate of Economics & Statistics.

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2. The terms of reference of the Expert Group will be as under :

(a) To examine the economic rationality of the present cropping pattern in different regions keeping in view the agro-climatic conditions, existing infrastructure, demand for different agricultural commodities and the special objective of maximising productivity per unit of land area;

(b) To determine socially optimum cropping patterns for different regions consistent with relative welfare of various regions;

(c) To determine socially optimum enterprise combinations comprising crop (including horticulture), livestock and forestry activities and determine production potential of different regions;

(d) To identify technological and resource gaps and determine resource requirements for achieving the production potential as determined vide (c) above;

(e) To suggest measures including pricing policy for achieving the optimum cropping pattern and production potential of different regions; and

(f) To cover any other aspect that the Expert Group may consider relevant.

3. The Expert Group may submit its report within a period of six months. The secretariat and technical assistance to the Expert Group will be provided by the Directorate of Economics & Statistics. Expenditure incurred in connection with the task assigned to the Expert Group will be met from out of the budget grant of the Directorate of Economics & Statistics.

Sd/-
(Harmohinder Singh)
Under Secretary to the Govt. of India

ANNEXURE 'B'

CALENDAR OF FUNCTIONING OF THE EXPERT GROUP ON CROPPING PATTERN

1. Date set up	19-2-1985
2. First Meeting	19-3-1985
3. Appointment of Consultant	April, 1985
4. Meeting of the Technical Group	25-7-1985
5. Second Meeting	13-9-1985
6. Tenure Extended upto 18-2-1986	9-10-1985
7. Interim Report submitted	7-11-1985
8. Tenure Extended upto 31-8-1986	19-3-1986
9. Meeting with State Irrigation Secretaries	25-4-1986
10. Commissioning of Consultancy Study on Impact of Water Management on Cropping Patterns in Irrigated Command Areas (ORG Study)	7-5-1986
11. Submission of Interim Report by ORG	July, 1986
12. Submission of ORG Study Report	31-7-1986
13. Tenure Extended upto 31-12-1986	8-10-1986
14. Submission of Modified Version of ORG Study	24-12-1986
15. Tenure Extended upto 31-5-1987	9-3-1987
16. Final Meeting	15-5-1987

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CHAPTER II

TRENDS IN CROPPING PATTERN

2.1 CROPPING PATTERN refers to proportions of total cropped area allocated to different crops. In any region, the present cropping pattern is the cumulative result of past and present decisions by individual farmers, communities, government or their agencies. These decisions have been governed by various factors including productivity, expected profit, resource structure and so on. Trends in cropping pattern point to the likely pattern in the supply of agricultural products in future.

Existing Cropping Pattern and its Rationality

2.2 Trends in cropping patterns at the all-India level as reflected by area under different crops and their proportions to total cropped area during the period 1950-51 to 1983-84 are shown in Table 2.1. Table 2.2 presents the all-India cropping patterns separately for irrigated and unirrigated areas in 1983-84 as compared to 1960-61.

2.3 Table 2.1 shows that during the first decade of planning *i.e.*, from 1950-51 to 1960-61, there was not much change in the cropping pattern in spite of significant increase of about 21 million hectares in cropped area. The proportion of area under rice and wheat together remained around 30 per cent of the total cropped area during 1950-51 to 1960-61. There was a marginal increase in proportion of area under sugarcane, groundnut, cotton and pulses during this period.

2.4 The introduction of dwarf high yielding varieties for major cereals *e.g.*, rice and wheat and hybrids and composites of millets in mid-sixties ushered in the 'Green Revolution'. Adoption of high yielding varieties on a large scale, increased use of fertilisers, plant protection chemicals and expansion in irrigated area led to a shift in area towards crops in which the impact of technology on yield was apparent. The proportion of area under wheat has been showing a continuous increase over time. It increased from 8.46 per cent in 1960-61 to 11 per cent in 1970-71 and 13.63 per cent in 1983-84. As against this, the proportion of area under coarse cereals recorded a declining tendency. The percentage of area under jowar to total cropped area decreased from 12.06 in 1960-61 to 9.07 per cent in 1983-84, while that of bajra and small millets decreased from 7.51 and 3.27 to 6.60 and 2.02, respectively. Even though there was some increase in the percentage of area to total cropped area under maize in 1970-71 when compared to 1960-61, it declined marginally thereafter.

2.6 Area under rice as a proportion of total cropped area remained unchanged at around 23 per cent during the entire period of planned development (1950-51 to 1983-84). In other words, growth rate of area under rice was similar to that of growth rate of total cropped area. Amongst non-foodgrain crops, the share of area under sugarcane, rapeseed & mustard and potato in total cropped area recorded significant increases while those of groundnut, cotton and jute have been fluctuating.

2.6 (a) Changes in cropping patterns between 1967-68 to 1984-85 on a State-wise basis are presented in Table 2.3. Some of the States witnessed quite substantial changes in their cropping patterns. For instance, the area under rice almost quadrupled in Punjab from 5.75 per cent of the gross cropped area in 1967-68 to 21.28 per cent in 1984-85 and in Haryana went up from 4.41 per cent to 9.57 per cent during this period. On the other hand, the share in some of the traditional rice producing States such as Assam, Kerala and Orissa declined by 7.5, 4 and 8 per cent points of the gross cropped area. In case of wheat, Bihar and Haryana showed sizeable gains. In Bihar share of area under wheat more than doubled and in Haryana its proportion increased from 16.15 per cent to 31.6 per cent. The area under wheat in Punjab and U.P. also increased by 12 to 13.6 percentage points, respectively. The area under coarse cereals witnessed a general decline during this period. For instance, in case of jowar, Andhra Pradesh recorded a decrease from 19.9 per cent to 15.3 per cent of gross cropped area, Gujarat from 12.8 to 8.8 per cent and Karnataka from 26.4 to 19.8 per cent. At the all-India level, area under oilseeds improved marginally from 10.25 per cent of the gross cropped area in 1967-68 to 10.62 per cent in 1984-85. In some important oilseeds producing States the share of these crops in total area registered a decline. For instance, the proportion of area under oilseeds in Karnataka decline by 13 percentage points, in U.P. by 4.2 percentage points and in Punjab by 3.5 percentage points. However, in some States like Andhra Pradesh, Assam, Gujarat, J. & K. and Orissa the share of oilseeds improved in the range of 2 to 5.5 per cent of the gross cropped area.

Growth Rates of Area under Crops

2.7 Growth rates of area under principal crops at the all-Indian level between 1949-50 to 1964-65 (Period I) and 1967-68 to 1984-85 (Period II) are shown in Table 2.4.

Pre-Green Revolution Period

• 2.8 An examination of growth rates of area under different crops shows that area expansion during pre-green revolution period (1949-50 to 1964-65) was relatively higher than in the post-green revolution period (1967-67 to 1984-85) being 1.61 and 0.46 per cent per annum, respectively. Further, during period I, growth in area took place in almost all the principal crops, except for small millets and barley and not much changes in cropping pattern were observed during that period. Annual growth rates of area under rice and wheat during the period 1949-50 to 1964-65 were 1.33 and 2.68 per cent per annum, respectively. Further, during period I, area under pulses and coarse cereals also witnessed a proportionate increase. However, sugarcane, cotton, groundnut, potato, *etc.*, showed relatively higher rates of area growth.

Post-Green Revolution Period

2.9 Growth rates of area under principal crops during period II were quite uneven resulting in marked changes in cropping pattern. Amongst the foodgrain crops, wheat witnessed the highest rate of growth of area (2.58 per cent per annum) as against the overall per annum growth rate of area at 0.46 per cent. Growth rate of area under rice was only marginally higher (0.66 per cent per annum) than the growth rate of area under all crops. Similarly, ragi had a positive growth rate of area at 0.41 per cent per annum.

2.10 Amongst pulses, gram—the major pulse crop which accounts for 40 per cent of the pulse area, recorded a negative growth rate of −0.50 per cent per annum. Tur and other pulses, however, showed a positive and significant growth rate of area. Among coarse cereals, jowar, bajra, maize, small millets and barley have shown a net decline in area.

2.11 Amongst oilseeds also there was a marked change in the pattern of area in recent years. Groundnut showed very low rate of growth (0.12 per cent per annum) as against as high a growth rate as 4.01 per cent during the earlier period (1949-50 to 1964-65). Growth rate of area under rape & mustard was relatively low in recent years. Growth rate of area under sesamum was negative. Although some area has been brought under new oilseeds such as soyabean and sunflower, the overall rate of growth of area under oilseeds during period II was only one-fifth of that observed during the period 1949-50 to 1964-65. Because of this slowing down in area expansion, the production of seven major oilseeds has grown at only about 1.91 per cent per annum, in spite of the reasonably high growth in productivity at the rate of 1.45 per cent per annum.

2.12 Amongst commercial crops, sugarcane, potato, jute and plantation crops have shown significantly higher rate of growth of area as compared to area under all crops. Area under cotton has grown relatively more slowly during this period, although in more recent years (1981—85) there was some step up in the rate of growth.

Shift in Cropped Area and Changes in Cropping Pattern

2.13 During the period 1967-68 to 1984-85, shifts in cropped area within foodgrain crops is quite marked. During kharif season, shift has taken place from millets (jowar, bajra) to rice. Amongst rabi crops, barley and gram with negative growth-rates, seem to have been replaced by wheat. It would be relevant to mention in this context that millets, barley and gram are grown mostly under rainfed conditions and whenever there has been an expansion in irrigation facilities, farmers have shown preference for crops like wheat and potato, which are high yielding, less risky and more remunerative.

2.14 Expansion in irrigation facilities has played an important role in causing a shift in cropping pattern. It has been observed that over 70 per cent of the additional irrigated area, of about 26 million hectares, developed between 1960-61 to 1983-84 was accounted for by wheat and paddy. Wheat alone accounted for about 53 per cent of the additional irrigated area. This would become apparent from Table 2.2.

2.15 Thus, as irrigation facilities are extended to newer areas, farmers in those areas favour paddy in kharif and wheat in rabi and other assured and high yielding crops depending upon the agro-climatic conditions and soil type of the regions. The principal cash crops accounting for additional irrigated area of about a million hectare each were sugarcane, groundnut, rapeseed & mustard, cotton and fruits & vegetables and the share of these crops in the total irrigated area has gone up over time.

Recent Trends in Growth of Area

2.16 Rates of growth of area under selected crops during the period 1980-81 to 1985-86 have been examined by us *vis-a-vis* those obtaining during the earlier periods. The rate of growth of total cropped area had declined to the marginal level of 0.15 per cent per annum in the recent period of 1980-81 to 1985-86 as against 0.54 to 0.68 per cent per annum during the period 1960-61 to 1979-80 and 1.64 during the period 1950-51 to 1959-60. Because of very slow growth rate of total gross cropped area, crops which have shown high rates of growth of area have done so at the cost of crops with low or negative growth rates.

2.17 In recent years, crops like rice, wheat, tur and other pulses except gram, amongst foodgrains have shown relatively higher rate of growth in area. Area under jowar, maize, bajra and gram have shown a declining trend. In case of kharif oilseed crops, groundnut, sesamum, linseed and nigerseed have shown decline in area. On the other hand, increase in area was observed in case of rabi groundnut, rape & mustard, castor seed and newly introduced crops of sunflower and soyabean. A significant growth in area was observed in case of cotton, jute & mesta whereas sugarcane has not shown any significant increasing trend in area.

2.18 Because of these trends in area, as well as differential rates of growth in yield per hectare, growth rate of production was positive and significant in case of rice, wheat, total pulses, oilseeds, cotton and jute. Growth rates of production of total pulses and oilseeds were 3.46 and 3.83 per cent per annum during 1980-81 to 1985-86 as against 1.49 and 1.39 per cent per annum, respectively during the period 1970-71 to 1978-79. Sugarcane production in recent years (1980-81 to 1985-86) has shown relatively lower growth rate (0.52 per cent) as against 4.19 per cent per annum during the period 1970-71 to 1978-79.

Rationale of Existing Cropping Pattern

2.19 Cropping pattern is governed by a complex of socio-economic, agro-climatic and physiological factors and it varies from region to region and also from farm to farm, within a region. Since sociological and agro-climatic factors are difficult to quantify at the macro level, the rationale of existing cropping pattern needs to be examined in the light of economic factors *i.e.*, productivity and profitability aspects of crop husbandry. Relative profitability of competing crops could change over time due to changes in relative productivity and in relative input and output prices. The value productivity of a crop net of costs of production indicates the margin of profitability at a point of time. Even a comparison of gross value productivity provides a broad indicator of changing profitability levels since input prices do not change considerably from year to year.

2.20 Amongst foodgrains crops, wheat accounted for maximum shift in area as well as highest growth in yield per hectare (3.04 per cent per annum). Rice showed a moderate rate of growth of productivity as also of area. Jowar and bajra recorded negative growth rates of area in spite of significant rates of growth in productivity. Crops which have witnessed significant growth rates in their productivity, as also increases in area greater than average for all crops, are sugarcane, potato, rape & mustard, jute & mesta, tea and coffee. A simultaneous increase in area as also in productivity indicates that farmers have shifted area in favour of crops in which there was a technological development.

2.21. Millets like jowar, bajra, *etc.*, evinced net decline in area, in spite of an increase in productivity during 1967-68 to 1984-85. However, even at these higher yield levels, their value productivity was only 25 to 40 per cent of that of rice and wheat in most of the States. Besides, there was greater risk in the production of these crops under the present technology in rainfed areas, where these are by and large cultivated. Irrigated area under these crops accounts for only 5 to 12 per cent of the total cropped area.

2.22 Production of pulses on the long term basis was stagnating and its area shrinking. This trend may be attributed first to stagnation or even marginal decline in productivity. The decline in yield of pulses was the result of shift of better land (wherever irrigation was extended) to other crops and its cultivation being continued on marginal land. Secondly, in spite of a rise in relative prices, ratio of gross value productivity (gross income) from pulses as compared to that from cereals, remained very unfavourable. In fact, this ratio has deteriorated over the years. Gross value productivity of gram, a major pulse crop, which was about 75 per cent of wheat in 1970-71 came down to almost half in early eighties. Moreover, this was associated with high risk and uncertainty which discouraged farmers to expand area under these crops.

2.23 In case of oilseeds, although the position is not as bad as that for pulses, the growth in productivity has been moderate. There have been increases both in productivity and prices with the result the total value productivity of oilseeds in recent years have shown some improvement.

2.24 In case of rapeseed & mustard there has been growth of 1.49 per cent per annum in its yield. This coupled with increase in its price which has brought the value productivity of this crop almost on par with that of competing crops. The value productivity of rapeseed & mustard was about 80 per cent of irrigated wheat in Punjab, Haryana and Uttar Pradesh. This crop was placed in a favourable position compared to them in areas which have no irrigation or have only protective irrigation facilities. Because of this, the acreage under rapeseed & mustard has shown an increase of 1.55 per cent per annum during the recent years (1980-81 to 1984-85).

2.25 Groundnut has not shown much increase in area particularly in the post green revolution period. The compound growth rate of area under groundnut during 1967-68 to 1984-85 was only 0.12 per cent per annum. This could be attributed, to some extent, to low rate of growth of its productivity (1.16 per cent per annum) as against potato (3.37 per cent), jowar (2.67 per cent) and bajra (1.55 per cent) which compete with groundnut in different States. The prices of groundnut during the period 1967-68 to 1984-85 have increased at a much higher rate compared to competing crops. Lack of adequate development effort and of transfer of technology were the major constraints in expansion of acreage under groundnut.

2.26 Amongst other commercial crops, major shift in acreage has taken place in favour of potato, sugarcane and jute & mesta. Growth rate of area under potato was 3.90 per cent per annum during 1967-68 to 1984-85. Corresponding growth rates for sugarcane and jute were 1.81 and 0.74 per cent per annum, respectively. It may also be observed that physical productivity of potato and sugarcane was already very high in the base period and a reasonably high growth rate over the initially high level have made these crops highly profitable. Expansion in area has occurred in favour of those crops which have either shown a high growth rate of productivity due to technological development, or relative prices with competing crops have moved in their favour or high growth rates in yield were combined with high prices resulting in sharp increases in their total value productivity. Thus farmers' decisions on area allocation between crops are founded on sound economic criteria.

2.27 All crops which have gained in area fall in either of the above three categories. For example, in wheat and rice, large increases in yield have taken place due to varietal improvements. Growth in area under some of the oilseeds like rape & mustard as also soyabean may be attributed to factors in the second category whereas potato and sugarcane may be placed in the third category.

2.28 Another aspect which needs to be considered is that a mere increase in the price of an agricultural commodity has only a limited impact on expansion of acreage under it. This can best be illustrated by pulses and oilseeds, whose support prices have been increased more than proportionately compared to those of major cereals like rice and wheat but the growth rates of area under and production of these crops remained much lower. In case of wheat and rice, varietal and other technological developments resulted in high rates of growth in their productivity which ultimately induced the farmers to shift areas in their favour. Development of technology, in association with appropriate price and market support, only succeeds in shifting cropping pattern in favour of a crop.

2.29 An important feature of the prices of pulses and oilseeds is the significant seasonal fluctuation. Study of seasonal variations in the prices of these commodities has revealed that there is a marked downward trend in the post-harvest seasons and a steep upward trend in the lean marketing seasons. Although such behaviour in price of agricultural commodities is a general phenomenon as their production and supply is seasonal in nature but this behaviour is more pronounced in the case of pulses, oilseeds and other crops for which adequate market support has somewhat been lacking.

2.30 The downward trend in prices during the post-harvest period increases the price uncertainty and risk in the production of pulses and oilseeds, particularly when there is already a high technological constraint, as they are highly susceptible to pests, diseases and moisture stress which lead to sharp fluctuations in yield per hectare. It is, therefore, imperative that besides the development of technology, efforts should be made to stabilise the prices of these commodities to check sharp inter-season variations. This calls for adequate market support besides reasonably remunerative guaranteed price.

2.31 This Group feels that farmers are generally quite rational in their choice and combination of crop enterprises, in the context of their access to resources and capacity to invest. Studies have shown that farmers in India have very high levels of efficiency in combining resources and crop enterprises under given technological possibilities and factor and product price relationships. This fact is reflected in trends and shifts in cropping pattern which show that farmers have increased area under wheat and rice because they found that these crops are more productive and remunerative as compared to any other crop rotation/crop combination which can substitute that in any region. Production of pulses and oilseeds is stagnating and its area is shrinking as this group of crops yields only about one-third or half of the gross income per unit of area as compared to that of other major cereals of rice and wheat.

Table 2·1—*All-India Cropping Pattern*—1950-51 *to* 1983-84

(Area in thousand ha.)

Crop	1950-51		1960-61		1970-71		1980-81		1983-84	
Rice	31056	(23·6)	34056	(22·3)	37381	(22·6)	40281	(23·3)	41436	(22·9)
Wheat	10010	(7·6)	12931	(8·5)	18293	(11·0)	22247	(12·8)	24718	(13·7)
Jowar	15554	(11·8)	18426	(12·0)	16871	(10·2)	16381	(9·5)	16447	(9·1)
Bajra	9744	(7·4)	11470	(7·5)	13391	(8·0)	11833	(6·8)	11823	(6·6)
Maize	3250	(2·4)	4401	(2·9)	5856	(3·5)	6056	(3·5)	5860	(3·2)
Ragi	2254	(1·7)	2478	(1·6)	2474	(6·5)	2512	(1·4)	2599	(1·4)
Barley	3198	(2·4)	3140	(2·1)	2556	(1·6)	1805	(1·0)	1393	(0·7)
Other Cereals & Millets	5576	(4·2)	4997	(3·3)	4962	(3·0)	4060	(2·4)	3719	(2·1)
TOTAL CEREALS	80542	(61·1)	91899	(60·2)	101784	(61·4)	105170	(60·7)	107995	(59·9)
Gram	7803	(5·9)	9274	(6·1)	7820	(4·7)	6566	(3·8)	7162	(4·0)
Tur	2228	(1·7)	2429	(1·6)	2639	(1·6)	2940	(1·7)	3150	(1·7)
Other Pulses	10523	(8·0)	11962	(7·8)	12667	(7·7)	13290	(7·7)	13499	(7·5)
TOTAL PULSES	20554	(15·6)	23665	(15·5)	23126	(14·0)	22796	(13·2)	23811	(13·2)
TOTAL FOODGRAINS	101196	(76·7)	115564	(75·7)	124910	(75·4)	127966	(73·9)	131806	(73·1)
Sugarcane	1757	(1·3)	2417	(1·6)	2589	(1·6)	2830	(1·6)	3260	(1·8)
Condiments & Spices	1244	(0·9)	1569	(1·0)	1864	(1·1)	2081	(1·2)	2208	(1·2)
TOTAL FRUITS	753	(0·6)	1096	(0·7)	1450	(0·9)	1909	(1·1)	2029	(1·1)
Potatoes	177	(0·1)	368	(0·2)	482	(0·3)	727	(0·4)	815	(0·5)
Onions	78	(0·1)	105	(0·1)	179	(0·1)	254	(0·1)	274	(0·2)
TOTAL VEGETABLES	1514	(1·2)	1553	(1·0)	2233	(1·3)	2969	(1·7)	3192	(1·8)
Groundnut	4406	(3·3)	6467	(4·2)	7552	(4·6)	6924	(4·0)	7462	(4·1)
Rapeseed & Mustard	1053	(0·8)	1145	(0·8)	1415	(0·9)	2263	(1·3)	2724	(1·5)
Sesamum	1957	(1·5)	1575	(1·0)	1853	(1·1)	1795	(1·0)	1918	(1·1)
Linseed	1226	(0·9)	1267	(0·8)	1199	(0·7)	1152	(0·7)	1290	(0·7)
Other Oilseeds	2326	(1·8)	2323	(1·5)	2700	(1·6)	3778	(2·2)	1629	(0·9)
TOTAL OILSEEDS	10968	(8·3)	12777	(8·3)	14719	(8·9)	15912	(9·2)	18306	(10·1)
Cotton	5655	(4·3)	7610	(5·0)	7830	(4·7)	7868	(4·5)	7720	(4·3)
Jute	561	(0·4)	633	(0·4)	753	(0·4)	940	(0·5)	791	(0·4)
Mesta	65	(0·1)	281	(0·2)	332	(0·2)	360	(0·2)	292	(0·2)
TOTAL FIBRES	6667	(5·1)	8762	(5·7)	9109	(5·5)	9328	(5·4)	8994	(5·0)
Tobacco	379	(0·3)	401	(0·3)	431	(0·2)	463	(0·3)	452	(0.3)
Other Crops	7433	(5·6)	8633	(5·7)	8486	(5·1)	9638	(5·6)	10566	(5·9)
TOTAL CROPPED AREA	131893	(100·0)	152772	(100·0)	165791	(100·0)	173096	(100·0)	180361	(100·0)
Area Sown more than once	13147	(10·0)	19573	(12·8)	25007	(15·1)	32797	(18·9)	37617	(20·86)
Net Sown Area	118746	(90·0)	133199	(87·2)	140784	(84·9)	140299	(81·1)	142744	(79·14)

NOTE.—Figures in brackets indicate per cent share in total cropped area.

TABLE 2·2—*All-India Cropping Pattern in Irrigated/Unirrigated Area*—1960-61 *to* 1983-84

('000 hectares)

Crops	1960-61				1983-84				Distribution of additional irrigated area	
	Irrigated		Unirrigated		Irrigated		Unirrigated			
	Area	Per cent	Area	Per cent	Area	Per cent	Area	Per cent	Area	Per cent
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Rice	12523	(44·7)	21533	(17·3)	17430	(32·3)	24006	(19·0)	4907	(18·9)
Jowar	655	(2·3)	17771	(14·2)	648	(1·2)	15799	(12·5)	(–)7	(Neg.)
Maize	556	(2·0)	3845	(3·1)	977	(1·8)	4883	(3·9)	421	(1·6)
Wheat	4233	(15·1)	8698	(7·0)	17886	(38·2)	6832	(5·4)	13653	(52·6)
Barley	1334	(4·8)	1806	(1·4)	658	(1·2)	735	(0·6)	(—)676	(—)2·1
TOTAL CEREALS & MILLETS	20166	(72·1)	71733	(57·5)	38488	(71·4)	69507	(55·0)	18322	(70·6)
Gram	1107	(4·0)	8167	(6·5)	1027	(1·9)	6135	(4·9)	(—)80	(—)0·3
TOTAL PULSES	1899	(6·8)	21766	(17·4)	1718	(3·2)	22093	(17·5)	(—)181	(—)0·7
TOTAL FOODGRAINS	22065	(78·9)	93499	(74·9)	40206	(74·5)	91600	(72·5)	18141	(69·9)
Sugarcane	1674	(6·0)	743	(0·6)	2593	(4·8)	667	(0·5)	919	(3·5)
Condiments & Spices	417	(1·5)	1152	(0·9)	855	(1·6)	1353	(1·1)	438	(1·7)
TOTAL FRUITS & VEGETABLES	477	(1·7)	2172	(1·8)	1963	(3·6)	3253	(2·6)	1486	(5·7)
Groundnut	195	(0·7)	6272	(5·0)	1277	(2·4)	6185	(4·9)	1082	(4·2)
Rapeseed & Mustard	138	(0·5)	1007	(0·8)	1277	(2·4)	1447	(1·1)	1139	(4·4)
TOTAL OILSEEDS	421	(1·5)	12356	(9·9)	3057	(5·7)	15249	(12·1)	2636	(10·2)
Cotton	967	(3·4)	6643	(5·3)	2271	(4·2)	5449	(4·3)	1304	(5·0)
Tobacco	88	(0·3)	313	(0·3)	157	(0·3)	295	(0·2)	69	(0·3)
Other Crops	1871	(6·7)	7914	(6·3)	2835	(5·3)	8558	(6·7)	964	(3·7)
TOTAL AREA	27980	(100·0)	124792	(100·0)	53937	(100·0)	126424	(100·0)	25957	(100·0)

TABLE 2.3—*State-wise Cropping Pattern during Triennium ending* 1967-68 *and* 1984-85

(% of Gross Cropped Area)

State	Year T.E.	Rice	Jowar	Bajra	Maize	Ragi	Wheat	Barley	Gram	Tur	Other Pulses
Andhra Pradesh	1967-68	26·25	19·90	4·73	1·78	2·59	0·11	—	0·60	1·44	8·53
	1984-85	29·67	15·31	3·61	2·56	1·88	0·14	—	0·44	1·96	8·81
Assam	1967-68	71·66	—	—	0·86	—	0·22	—	0·07	0·11	12·94
	1984-85	64·19	—	—	0·53	—	2·81	—	0·11	0·28	3·28
Bihar	1967-68	48·58	0·11	0·14	8·38	1·76	8·22	3·40	3·50	1·64	13·53
	1984-85	48·11	0·06	0·12	7·47	1·39	18·30	0·94	1·85	0·86	9·14
Gujarat	1967-68	5·02	12·77	16·31	2·31	0·62	4·97	0·03	0·36	0·89	2·79
	1984-85	4·95	8·78	13·16	2·93	0·43	6·34	0·07	1·24	2·79	3·35
Haryana	1967-68	4·41	5·88	18·51	2·11	—	16·15	4·21	22·53	0·11	1·93
	1984-85	9·57	2·55	14·39	1·07	—	31·60	1·36	10·77	0·29	0·75
Himachal Pradesh	1967-68	11·20	—	—	27·89	1·49	33·37	4·57	2·06	0·11	4·57
	1984-85	9·51	—	—	30·72	0·84	36·78	3·34	0·42	—	3·97
J. & K.	1967-68	26·56	—	1·80	29·69	—	21·39	2·16	0·24	—	5·77
	1984-85	27·18	—	1·88	27·48	—	21·13	0·99	0·10	—	4·66
Karnataka	1967-68	10·88	26·40	5·37	0·35	9·34	2·72	0·04	1·62	2·75	6·94
	1984-85	10·37	19·82	4·85	1·47	9·43	2·94	—	1·43	3·41	8·70
Kerala	1967-68	30·26	0·04	—	—	0·19	—	—	—	0·34	1·32
	1984-85	26·31	0·04	—	—	0·04	—	—	—	—	1·09
Madhya Pradesh	1967-68	22·57	12·32	1·31	3·02	0·10	12·90	0·79	8·79	2·51	9·33
	1984-85	21·86	9·24	0·78	3·64	0·09	16·29	0·72	9·81	2·25	10·17
Maharashtra	1967-68	7·03	32·14	9·37	0·20	1·17	4·53	0·02	1·86	2·97	7·28
	1984-85	7·31	31·90	8·02	0·42	1·10	5·16	0·04	2·33	3·50	7·69
Manipur	1967-68	86·89	—	—	3·28	—	—	—	—	—	—
	1984-85	86.63	—	—	2·67	—	—	—	—	—	—
Meghalaya	1967-68	—	—	—	—	—	—	—	—	—	—
	1984-85	52·13	—	—	8·53	—	1·42	—	—	0·47	0·47
Nagaland	1967-68	—	—	—	—	—	—	—	—	—	—
	1984-85	61·83	—	—	9·68	—	—	—	—	—	2·15
Orissa	1967-68	55·03	0·09	0·05	0·70	1·52	0·18	—	0·27	0·41	9·75
	1984-85	47·00	0·37	0·09	2·03	3·29	0·81	—	0·50	1·38	16·81
Punjab	1967-68	5·75	0·10	3·54	8·42	—	32·07	2·05	11·60	0·04	0·99
	1984-85	21·28	0·01	0·69	4·32	—	44·36	0·92	0·47	0·47	0·89
Rajasthan	1967-68	0·57	7·07	31·41	4·74	—	6·78	3·14	5·42	1·72	12·66
	1984-85	0.82	5·08	25·84	4·93	—	10·89	1·64	0·16	0·16	9·75
Tamil Nadu	1967-68	35·98	10·39	6·05	0·07	4·54	0·01	—	0·03	0·72	4.80
	1984-85	32·90	10·04	4·86	0·32	3·34	—	—	1·97	1·97	8. 66
Tripura	1967-68	74·77	—	—	—	—	—	—	—	—	0·90
	1984-85	76·15	—	—	—	—	0·81	—	0·27	—	1·36
Uttar Pradesh	1967-68	19·52	3·98	4·58	5·81	0·77	20·16	6·89	10·81	2·91	5·54
	1984-85	21·26	2·48	3·93	4·50	0·66	33·83	2·51	2·03	2·03	4·00
West Bengal	1967-68	70·09	0·03	—	0·75	0·14	0·87	0·71	2·57	0·59	8·18
	1984-85	68·44	—	—	0·75	0·19	0·13	0·32	0·29	0·29	3·94
Other States/ U.Ts.	1967-68	34·29	1·75	3·03	0·16	0·48	5·42	0·64	2·07	0·16	0·64
	1984-85	38·80	1·82	1·54	9·10	2·24	8·12	0·28	0·42	0·42	2·24
ALL-INDIA	1967-68	22·49	11·37	7·77	3·24	1·53	8·48	1·86	5·09	1·62	7·44
	1984-85	22·75	9·15	6·30	3·28	1·30	13·55	0·78	1·76	1·76	7·23

TABLE 2.3—*Contd.*

Sugarcane	Groundnut	Rapeseed & Mustard	Cotton	Jute & Mesta	Tobacco	Potato	Other Crops	Total Foodgrains	Total Oilseeds
1·05	10·11	0·01	2·42	0·72	1·47	0·01	18·28	72·93	14·94
1·18	12·74	0·01	3·79	0·63	1·62	—	15·65	67·95	17·09
1·15	—	4·73	0·61	5·34	0·36	1·40	10·69	76·08	5·20
1·36	—	8·08	0·11	3·36	0·14	1·25	14·50	71·50	8·75
1·57	0·05	0·76	0·02	2·95	0·15	0·93	4·31	91·47	1·97
1·22	0·07	0·88	—	1·53	0·13	1·35	6·58	89·37	2·39
0·34	19·68	0·28	16·69	—	0·81	0·04	16·09	47·51	21·69
0·94	19·62	1·69	13·39	—	1·02	0·09	19·21	45·10	24·68
3·69	0·30	4·34	4·49	—	0·02	0·09	11·23	76·11	4·67
2·46	0·15	4·09	6·68	—	—	0·15	14·12	72·33	4·31
0·46	0·23	0·57	0·11	—	0·11	2·06	11·20	88·80	2·29
0·31	0·10	0·63	—	—	—	1·36	12·02	88·09	2·19
0·24	—	3·25	0·12	—	—	0·24	8·54	89·78	4·81
0·10	—	4·96	—	—	—	0·20	11·32	85·02	5·85
0·81	7·86	0·04	9·83	0·27	0·33	0·08	14·37	69·97	10·66
1·64	7·71	0·03	8·17	0·24	0·43	0·19	19·37	65·51	14·21
0·30	0·53	—	0·26	—	0·04	—	66·72	32·37	0·98
0·28	0·35	—	0·21	—	—	—	71·68	27·61	0·88
0·32	2·65	0·70	4·41	0·06	0·02	0·08	18·12	81·97	8·62
0·22	1·47	1·33	2·48	0·03	—	0·13	19·49	81·28	10·63
0·92	5·61	0·02	14·16	0·27	0·08	0·07	12·29	67·66	9·31
1·47	3·80	0·02	12·95	0·29	0·05	0·06	13·89	68·33	10·63
—	—	—	—	—	—	—	9·83	90·16	
1·07	—	1·60	—	—	—	1·07	6·96	90·37	2·14
—	—	—	—	—	—	—	—	—	—
—	—	2·37	4·26	4·74	—	8·53	17·08	64·93	2·84
—	—	—	—	—	—	—	—	—	—
1·61	—	1·61	—	—	—	2·15	20·97	74·19	2·15
0·53	0·83	0·80	—	0·82	0·17	0·40	28·45	69·31	4·[illegible]
0·55	3·03	1·28	0·02	1·25	0·20	0·10	21·29	74·18	9·68
3·10	3·49	2·21	8·46	—	—	0·27	17·91	64·59	6·02
1·28	0·86	1·44	8·83	—	—	0·39	13·79	74·52	2·51
0·29	1·48	1·43	1·66	—	0·04	0·01	21·58	74·57	7·61
0·19	1·14	4·55	4·30	—	0·02	0·01	30·52	68·66	8·64
1·49	12·80	—	5·00	—	0·19	0·12	17·81	69·16	14·47
2·53	14·68	0·01	3·09	—	0·16	0·13	15·32	66·41	17·41
0·90	—	1·20	0·90	7·51	0·30	0·90	12·62	75·68	1·80
0·54	0·27	0·81	0·27	2·98	0·27	0·54	15·73	78·59	1·90
6·10	1·81	8·68	0·29	0·09	0·05	0·67	1·35	83·47	16·91
6·68	0·96	6·43	0·11	0·03	0·06	1·22	7·28	81·88	10·72
0·48	—	1·59	—	7·59	0·23	1·19	4·99	84·08	2·27
0·28	0·07	2·69	—	6·69	0·20	1·82	13·90	79·08	4·96
0·80	0·64	—	—	—	—	—	49·92	48·64	0·80
0·70	0·42	2·24	0·28	—	—	0·70	30·68	68·63	3·78
1·65	4·73	1·92	4·99	0·72	0·26	0·30	14·54	73·83	10·25
1·78	4·24	2·28	4·34	5·90	2·59	0·45	10·47	72·21	10·62

NOTES.—1. Area of Meghalaya & Mizoram are included under Assam for T.E. 1967-68.

2. For T.E. 1967-68, Nagaland is included under other States/U.Ts.

TABLE 2·4—*All-India Compound Growth Rates of Area, Production and Yield of Principal Crops in India*

(In per cent per annum)

Crop	1949-50 to 1984-85			1949-50 to 1964-65			1967-68 to 1984-85		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Rice	0·9	2. 48	1·54	1·33	3·49	2·13	0·66	2·37	1·74
Wheat	2·78	6·01	3·14	2·68	3·99	1·27	2·58	5·70	3·04
Jowar	—0·18	1·35	1·54	0·99	2·50	1·50	—0·73	1·92	2·67
Bajra	0·28	2·12	1·85	1·08	2·34	1·24	—0·83	0·92	1·55
Maize	1·78	2·65	0·85	2·66	3·87	1·18	—0·08	1·03	1·12
Ragi	0·23	1·78	1·55	0·84	3·08	2·22	0·41	2·40	1·99
Small Millets	—0·83	—0·99	—0·15	—0·30	—0·20	0·09	—1·93	—1·52	0·41
Barley	—2·20	—0·94	1·29	—0·64	—0·28	0·36	—4·75	—3·25	1·56
Coarse Cereals	Neg.	1·46	1·32	0·90	2·23	1·29	—0·93	0·93	1·83
TOTAL CEREALS	0·82	2·97	1·81	1·30	3·24	1·68	0·35	2·92	2·12
Gram	—0·59	—0·03	0·46	1·64	2·66	0·54	—0·50	—0·55	—0·08
Tur (Arhar)	0·66	0·44	—0·23	0·57	—1·34	—1·90	1·17	1·88	0·70
Other Pulses	0·79	0·53	—0·25	2·07	1·28	—0·77	0·79	0·96	0·17
TOTAL PULSES	0·32	0·27	0·13	1·90	1·39	—0·22	0·42	0·51	0·19
TOTAL FOODGRAINS	0·71	2·62	1·67	1·41	2·93	1·43	0·36	2·68	2·14
Sugarcane	1·98	3·06	1·13	3·27	4·26	1·12	1·81	2·88	1·05
Groundnut	1·38	1·95	0·57	4·01	4·33	0·31	0·12	1·29	1·16
Sesamum	0·03	0·45	0·48	0·14	—0·32	—0·36	—0·42	1·06	1·51
Rapeseed & Mustard	1·82	3·25	1·41	2·97	3·36	0·37	1·55	3·07	1·49
Seven Oilseeds	1·11	2·10	0·78	2·64	3·34	0·13	0·44	1·91	1·45
Coconut	—	—	—	—	—	—	0·86	0·39	—0·46
TOTAL OILSEEDS	1·03	2·04	0·68	2·69	3·11	0·20	0·34	1·75	1·29
Cotton	0·46	2·42	1·96	2·47	4·56	2·04	0·06	2·25	2·19
Jute & Mesta	0·94	1·44	0·58	3·86	4·20	0·73	0·74	2·02	1·08
TOTAL FIBRES	0·45	2·13	1·60	2·57	4·45	1·68	0·11	2·11	1·90
Potato	3·98	6·03	1·97	4·37	4·27	—0·11	3·90	7·41	3·37
Tobacco	0·76	2·23	1·47	1·66	2·79	0·96	0·20	2·43	2·24
TOTAL NON-FOODGRAINS	1·18	2·63	1·08	2·52	3·54	0·93	0·75	2·60	1·43
ALL CROPS	0·81	2·63	1·49	1·61	3·13	1·30	0·46	2·66	1·91

N.—.Negligible.

NOTES.—1. Seven Oilseeds include Groundnut, Sesamum, Rapeseed & Mustard, Linseed, Castorseed, Nigerseed and Safflower.

2. Total Oilseeds include Seven Oilseeds, Coconut and Cottonseed.

CHAPTER III

ECONOMICS OF CROP ENTERPRISES

3.1 FARMERS' decisions about crop combinations and allocation of area and input resources are largely influenced by economic considerations. Analysis of economic rationale is, therefore, very important for any study on cropping patterns. This analysis has perforce to be attempted on the basis of data available from the Comprehensive Scheme for Cost of Cultivation of Crops. The sampling procedure of collecting these data is so designed as to generate the costs and returns obtaining at the State level. As such, meaningful conclusions cannot be drawn on inter-crop profitability in various agro-climatic regions within a State or across States. Only some rough indicative idea on relative profitability can be obtained by comparisons of costs and returns of competing crops.

3.2 In this Chapter, economics of cropping pattern has been examined from two aspects. Firstly, the economics of growing a crop in different States/regions, which would suggest the basis for regional specialisation and diversification of cropping pattern. Secondly, economics of different crops within a State so that an idea about the farmers' preference could be formed.

Yield and Gross Income of Different Crops

3.3 Yield and gross income per hectare of principal crops in various States is given in Tables 3.1 to 3.6. An idea of comparative net profitability of competing crops in selected States is given in Table 3.7.

3.4 Physical productivity per hectare was much higher for paddy and wheat as compared to other foodgrains in most of the States. A brief idea about crop-wise variations in productivity and economics of production is given below.

Paddy

3.5 Data on economics of paddy cultivation in major producing States for 1983-84 is presented in Table 3.1.

3.6 An examination of levels of yield and inputs used for paddy in different States shows that the average yield of paddy was 80 to 120 per cent higher than all-India average in the States of Andhra Pradesh, Karnataka, Punjab and Tamil Nadu. The level of fertiliser application in these States was almost three times the average. However, there are States like Assam, Bihar, Madhya Pradesh, Uttar Pradesh, Orissa and Kerala where yield per hectare is much below the national average. The output-input ratios in these States are high and the average level of consumption of fertiliser is low. These facts suggest that there is a good scope of increasing yield per hectare of paddy in the States of Assam, Bihar, Orissa, Uttar Pradesh and Madhya Pradesh through increased use of fertilisers and other yield increasing inputs.

3.7 Average fertiliser consumption per hectare in paddy cultivation during 1983-84 was only about 1 Kg. in Assam, 22 to 30 Kgs. in Bihar, Orissa, Madhya Pradesh and Uttar Pradesh as against 213 Kgs. in Punjab and between 140—150 Kgs. in Tamil Nadu and Andhra Pradesh. At the present level of fertiliser consumption, its marginal response ratio in the States of Assam, Bihar, Madhya Pradesh, Uttar Pradesh and Orissa is fairly high. If fertiliser consumption in the States of Assam, Bihar, Madhya Pradesh, Uttar Pradesh and Orissa can be raised by another 40 to 50 Kgs. per hectare, the average productivity of paddy in the States could be raised by about 4 to 5 quintals per hectare.

3.8 Since these low yielding States account for about 20 million hectares (half of the total area under rice), the increase in yield in these States would result in additional production of paddy of about 8 to 10 million tonnes. Besides, there will be normal increase in the yields of other States as also in States where the yields are above average. Thus, additional production of rice of about 12 to 15 million tonnes can be achieved by improving the efficiency and use of inputs without expanding area under this crop.

3.9 This, however, does not suggest that there should not be any expansion of area under rice. The expansion of area under rice could be effected in the regions which are more efficient and to the extent it is desired.

Wheat

3.10 The average productivity of wheat in States of Punjab, Haryana and Uttar Pradesh are higher than the national level. If we consider the return over paid out cost of cultivation which was over Rs. 2000 per hectare on an average, Punjab, Rajasthan and Bihar had high return, whereas Haryana and Uttar Pradesh were just almost equal to average. Himachal Pradesh and Madhya Pradesh have relatively low profitability in wheat production (Table 3.2).

3.11 Output-input ratio and level of application of fertilisers in wheat are important determinants of economic efficiency of production. Average fertiliser consumption per hectare in wheat production was about 160 Kgs. in Punjab, 118 Kgs. in Haryana and 90 Kgs. in Uttar Pradesh. It was only 45—50 Kgs. in Bihar and Rajasthan, about 30 Kgs. in Madhya Pradesh and 20 Kgs. in Himachal Pradesh. However, output-paid out cost ratio was relatively higher in the States of Bihar, Madhya Pradesh, Rajasthan and Himachal Pradesh which suggest that there was a good scope for increasing output of wheat by increasing use of purchased inputs, particularly fertilisers in all these States.

3.12 Irrigation is the major constraint in the production of wheat in Rajasthan and Madhya Pradesh. However, with improvement in the use-efficiency of existing irrigation water through better management and increased and balanced fertiliser application there is scope for increasing yield of wheat by about 50 to 70 per cent in Madhya Pradesh and Rajasthan and about 25 to 30 per cent in Uttar Pradesh and Bihar with the existing technology. This increase in productivity would result in an increase in wheat production by about 30 per cent.

3.13 Besides, States like Maharashtra, West Bengal *etc.*, have also taken up wheat production in a big way in the recent period. Yield in these States is generally higher than the all-India average. There is scope for expansion of area under wheat in these States.

Jowar

3.14 Jowar production in Karnataka shows high productivity, lowest cost of production per unit of output and highest output-input ratio (Table 3.3). Other States showing high productivity and high output-input ratios in jowar production are Madhya Pradesh, Gujarat and Uttar Pradesh. Maharashtra, the largest producer of jowar, has relatively high cost of production and low output-input ratio which shows that cultivation of this crop may have been extended to some marginal lands.

3.15 Going by trends and relative profitability of this crop, it is felt that it may not be possible to expand its area to any significant level in the near future. However, there seems to be significant scope for increasing its production through raising yield per hectare by extending the coverage under hybrid varieties and increased use of fertilisers particularly in areas which have relatively assured rainfall. The average productivity of jowar can be increased by over 30 per cent by transfer of available technology through appropriate extension efforts.

Bajra

3.16 Data on economics of its production based on cost of cultivation was available only for some selected States. Economics of bajra production as indicated by cost of cultivation per hectare/production per quintal and profitability *etc.*, is presented in Table 3.3.

3.17 It would be seen that Gujarat which had the highest yield per hectare, also has highest return over paid out cost (Cost A_2) in the production of bajra which was more than double that of Rajasthan and Haryana, Rajasthan which accounts for about 40 per cent of total area, had lowest yield per hectare, fertiliser consumption and per cent of irrigated area.

3.18 Level of fertiliser consumption per hectare was extremely low in bajra cultivation in Haryana and Rajasthan being 6.7 and 1.5 Kgs. per hectare, respectively (as against about 31 Kgs. in Gujarat) but output-paid out cost ratios were quite favourable. It suggests that considerable scope exists for increasing the productivity of bajra in Haryana, Rajasthan and also in Uttar Pradesh through increased use of fertiliser and other inputs.

3.19 Because of new technology, there is a significant potential for increasing the productivity of this crop. Considering the existing yield levels of this crop in different States, levels of input-use and scope for increasing its application, it is felt that productivity of bajra can be increased by about 50 per cent with the existing technology. However, this would call for greater extension efforts particularly in the States of Haryana, Rajasthan, Uttar Pradesh and Maharashtra.

Maize

3.20 Bihar shows the highest profit over cost per hectare in cultivation of maize (Table 3.3). This State also has the highest output-input ratio. Madhya Pradesh has lowest per hectare yield, value of output and profit.

3.21 The proportion of irrigated area to total area under maize was about 1 per cent in Madhya Pradesh and under 7 per cent in Himachal Pradesh. Fertiliser application per hectare (ranging between 10—19 Kgs.) was less than one-third of recommended doses. This crop is generally cultivated under rainfed conditions in kharif season when sufficient soil moisture is there. The yield of this crop, on an average, can be increased by about 300 Kgs. if average fertiliser consumption could be raised to about 35—45 Kgs. per hectare. It may not be difficult to achieve this level in next 5—8 years. The scope for increasing yield by adoption of hybrid varieties is much greater.

Groundnut

3.22 Data on economics of groundnut production available for major growing States are presented in Table 3.4. These data show that whereas yield per hectare was higher in Tamil Nadu and Maharashtra, cost of production per quintal of groundnut was lowest in Gujarat followed by Karnataka.

3.23 An important feature of groundnut production that emerges from these data is that, Gujarat, which is the largest producer of groundnut has almost lowest yield per hectare amongst the selected States in spite of the fact that fertiliser application for this crop is highest in this State. There is a need to examine this aspect in depth so that optimum return through increased yield could be attained for the resources applied in the production of this crop.

3.24 Orissa has picked up very fast in the production of groundnut in recent years. Details of economics of production of this crop are not available for the State. However, yield per hectare, as obtained from General Crop Estimation Surveys, was highest in orissa, being 1549 Kgs. as against all-India average of 870 Kgs. in 1984-85. In view of the general resource availability and application of inputs in agriculture in Orissa, it is felt that this crop has considerable prospect in the State. Past trends in expansion of area support this and also suggest that Orissa may become one of the leading producers of groundnut in the next decade.

Rapeseed & Mustard

3.25 It is evident from the economics of rape & mustard that this crop is quite profitable in all the States under study (Table 3.4). In spite of the fact that its average yield ranged between 6 to 8 quintals per hectare, value of its output and return over cost were significantly high. Return over paid out cost per hectare ranged between Rs. 2000—3000 whereas return over total cost (Cost C_2) which also takes into account imputed values of owned resources, was between Rs. 850—1550 in different States. This margin of profit in the production of rape & mustard was significantly higher than in most of the rabi crops including wheat in some of the States. Cost of prodution of this crop was relatively lower in relation to the value of output. This was evident from the high output-input ratios (ranging between 3.5—4.0 when Cost A_2 is considered and around 1.5 : 1 when Cost C_2 is considered).

3.26. The existing level of profitability of this crop suggests that it has an edge over competing crops. This explains a relatively higher growth rate of area under this crop (1.93 per cent per annum against 0.20 per cent per annum for all crop between the triennia ending 1979-80 and 1985-86). If the existing margin of profit in rapeseed & mustard continues, this crop is likely to gain in acreage even in irrigated areas.

3.27 The main features observed from economics of rapessed & mustard are that the crop has low yield, low fertiliser application and high output-input ratio. Fertiliser application per hectare for this crop in Assam was 1.97 Kgs., in Rajasthan 5.5 Kgs. and in Uttar Pradesh 22.7 Kgs. in 1983-84. Percentage of irrigated area to total area under the crops was higher in Rajasthan (57.3) as compared to Uttar Pradesh. Extension efforts need to be directed towards motivating farmers to increase the application of fertilisers and other package of practices at least in irrigated areas. This would help not only to raise the productivity but also to improve the overall profitability of this crop.

Gram

3.28 There are large variations in productivity and profitability of gram across the States (Table 3.5). Uttar Pradesh has highest yield rate per hectare as well as highest return over cost, whereas Haryana has lowest yield as well as profitability. Cost of production per quintal was highest in Haryana whereas it was around Rs. 210 in Uttar Pradesh, Madhya Pradesh and Rajasthan.

3.29 It appears that it would be quite economical to extend the cultivation of gram in Uttar Pradesh, Madhya Pradesh and Rajasthan.

3.30 Gram is being cultivated under very poor management conditions. The crop is, by and large, rainfed and the application of fertiliser was exceptionally low. It was only 1.5 Kgs per hectare in Rajasthan whereas it was less than a Kg. in Madhya Pradesh and Haryana. While it may be true that pulse crops require usually very low nitrogen but a dose of 25 to 30 Kgs. of phosphatic fertilisers per hectare would result in substantial increase in yield. It would, therefore, be desirable that the extension efforts should be directed to popularise the use of phosphatic fertilisers in the case of gram to improve its productivity. With improvement in management and increased use of fertilisers, the productivity of gram can be raised substantially in the States of Madhya Pradesh, Rajasthan and Haryana.

3.31 The other important gram producing States are Bihar and Gujarat. Cost of production data for these States were not available. However, yield per hectare in these States is quite high (around 900 kgs). It appears from this that these States have a very good potential for expansion of area under this crop.

Tur (Arhar)

3.32 Data on economics of tur production are available for Karnataka and Madhya Pradesh (Table 3.5).

3.33 Yield per hectare was highest in U.P. followed by Bihar and Madhya Pradesh. Productivity of tur was quite low in Karnataka, being less than half of that in Uttar Pradesh. Cost of production per quintal of tur in Madhya Pradesh was quite low as compared to that in Karnataka.

3.34 As in the case of gram, this crop is also being cultivated under poor management conditions. Irrigated area under the crop was almost negligible and fertiliser consumption was very low *i.e.,* only about 20 per cent of the recommended dose. There is, therefore, significant scope for improving the productivity of this crop through better management and increased use of fertilisers, particularly in Karnataka, Madhya Pradesh, Tamil Nadu and Andhra Pradesh where yields at present are very low.

Cotton

3.35 There are marked variations in yield as well as cost of cultivation/production of cotton between different States (Table 3.6). Output per hectare was quite high in Karnataka, Gujarat, Punjab and Andhra Pradesh. Maharashtra which has the largest area has very low output per hectare resulting in high cost of production per unit of output. Considering the paid out cost of production, cultivation of cotton appears most economical in Karnataka. Cost of production per unit of output was relatively high in Gujarat, Punjab and Maharashtra. Margin of profit as indicated by output-input ratio was low in Madhya Pradesh, Punjab and Gujarat.

3.36 An important fact that emerges from the cost data for cotton is that fertiliser consumption was highest in Karnataka followed by Gujarat and Punjab. These States also have relatively higher yield per hectare. Against this, the States of Madhya Pradesh and Maharashtra have very low productivity and the fertiliser consumption is also low. However, these States have favourable output-input ratios which indicate that there is scope for inreasing fertiliser consumption as well as productivity in these States.

Jute

3.37 Yield per hectare as well as the value of gross output of jute was much higher in Orissa and West Bengal whereas it was quite low in Bihar and Assam (Table 3.6).

3.38 Owing to the high output-input ratio in Bihar, Orissa and West Bengal, these States have relatively high margin of profit in the production of jute. But the output-input ratio during 1983-84 was not very favourable in case of Assam. It appears that farmers in Assam did not receive the same level of prices as those received by their counterparts in West Bengal or Orissa because in spite of the fact that their average yield was almost 50 per cent higher than in Bihar, the value of total output was just the same as in Bihar. This indicates that the prices received by the Assam farmers during that year could have been about 30 per cent lower than those received by the farmers in Bihar and West Bengal.

3.39 In the case of Assam and Bihar, application of fertiliser for jute was very low between 1 to 2 Kgs. per hectare as against about 28 Kgs. in West Bengal and 12 Kgs. in Orissa. This indicates that there is scope for increasing the productivity of jute in Bihar and Assam through the increased application of fertilisers.

Oilseeds and Pulses

3.40 We have examined the possibility of increasing area under oilseeds and pulses through shifts of area from the competing crops. Competing crops for major oilseeds and pulses were identified for each of the major States and profitability of competing crops based on data collected under the comprehensive scheme for studying cost of cultivation were examined. The net profitability of competing crops in selected States is given in Table 3.7.

3.41 It was observed that under the existing level of technology, yield and price structure, gross income as well as profitability over paid out cost as well as total cost was much higher in case of paddy than in groundnut in almost all the States. It, therefore, appears unlikely that groundnut can replace paddy to a significant extent in most of the States. The other competing crops for groundnut are bajra in Gujarat; jowar, ragi and cotton in Karnataka; and ragi in Tamil Nadu. At the existing level of yield and prices, groundnut does not appear to be more profitable than its competing crops in the respective States. However, as mentioned at the outset, these data for the competing crops may not strictly relate to comparable agro-climatic regions. Also quality of land and irrigation levels may not be the same for competing crops, for example for groundnut and paddy.

3.42 The other important crop is rapeseed & mustard. Crops which compete with it in most of the States are wheat and gram. Value of output per hectare of rapeseed & mustard was quite comparable with that of wheat and it was marginally lower in some States and higher in few other States. However, profitability over paid-out cost as well as total cost was much higher in the case of rapeseed & mustard when compared to wheat as well as gram in all the three States *i.e.,* Haryana, Rajasthan and Uttar Pradesh. It is thus evident that rapeseed & mustard can replace wheat, at the margin.

3.43 As regards gram, it was not found much profitable under the existing yield levels and price situations in Haryana and Rajasthan. However, its profitability over cost was marginally higher than that of wheat in Uttar Pradesh and it appeared that there was scope for shifting area to this crop in certain regions of the State.

3.44 Soyabean, which is a newly introduced crop, was found to be profitable over other kharif crops like paddy and jowar in Madhya Pradesh, and paddy in Uttar Pradesh. The returns from soyabean were much higher than for jowar in Madhya Pradesh and Paddy in Uttar Pradesh. In Madhya Pradesh, it was quite comparable with paddy. This shows that with price support soyabean could easily be substituted for jowar and paddy in Madhya Pradesh as well as Uttar Pradesh.

Substitution of Sugarcane

3.45 There has been a debate whether it would be advantageous to concentrate the production of sugarcane in tropical zones where the productivity was between 80 to 110 tonnes per hectare and shift the area from sugarcane to other crops in the sub-tropical zone where productivity was in the range of 4 to 7 tonnes per hectare.* In order to examine the feasibility of this proposition, we examined the economics of sugarcane *vis-a-vis* competing crops. Since sugarcane is a long duration crop, spread over almost whole of the year in the sub-tropical region, a crop rotation of competing crop was considered to study the comparative economics.

3.46 It has been observed that the net income from the substitute set of crops over crop rotation as a whole was lower than that from sugarcane. In Uttar Pradesh, profitability over paid out cost in the production of sugarcane was as high as Rs. 5955 per hectare as against Rs. 2719 in the maize-wheat rotation. Similarly, in case of Bihar, profitability over total cost in the production of sugarcane was Rs. 4437 as against Rs. 3618 in the maize-wheat rotation. This suggests that even in the low yielding States of Bihar and Uttar Pradesh, sugarcane production is more profitable in relation to its competing crops.

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*Relative economics of sugarcane in tropical and sub-tropical zones were discussed by us in depth in our Interim Report.

TABLE 3·1—*Economics of Paddy Production*

Sl. No.	State	Yield per hect.	Per hect. cost of cultivation		Gross output per hect.	Profit/Return over		Cost of production per qtl.		Output/Input ratio with		Fertilizer consumption per hect. (Rs./hect.)	Percentage area under	
			A_2	C_2		Cost A_2	Cost C_2	Cost A_2	Cost C_2	Cost A_2 (%)	Cost C_2 (%)		Irrigation	HYV
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1.	Andhra Pradesh	33·93	3291·55	5291·22	5412·98	2121·43	121·76	88·14	141·53	1·64	1·02	720·88	N/A	N/A
2.	Assam	19·46	884·40	2129·87	2778·66	1894·26	648·79	42·18	105·41	3·14	1·30	1·00	—	—
3.	Bihar	18·74	1181·85	2826·88	3940·53	2758·68	1103·65	55·92	133·32	3·33	1·39	135·22	—	—
4.	Karnataka	32·78	2101·52	4030·19	6196·20	4094·58	2165·01	55·57	103·94	2·95	1·54	418·27	—	—
5.	Madhya Pradesh	14·51	871·15	1746·76	2529·31	1658·16	782·55	51·88	102·93	2·90	1·45	74·05	—	—
6.	Orissa	21·75	1624·72	2793·68	3813·70	2188·98	1020·02	60·06	104·85	2·35	1·37	95·41	—	—
7.	Uttar Pradesh	23·09	1534·80	3054·64	3600·07	2065·27	545·43	59·97	118·95	2·35	1·18	224·63	—	—
8.	Punjab	52·82	4131·74	6482·42	7494·41	3362·57	1011·99	77·94	122·32	1·81	1·16	1055·40	—	—
9.	West Bengal*	15·88	1877·95	3287·57	3405·48	1527·53	117·91	97·36	171·29	1·81	1·04	162·93	—	—
10.	Tamil Nadu	39·20	3430·41	5191·24	5935·36	2504·95	744·02	77·07	118·45	1·73	1·14	—	—	—

*Since the data for 1983-84 has not been finalised, the data for 1982-83 has been taken.

TABLE 3·2—*Economics of Wheat Production*

Sl. No.	State	Yield per hect. (Qtls.)	Per hect. cost of cultivation		Gross output per hect. (Rs.)	Profit/Return over		Cost of production per qtl.		Output/input ratio with		Fertilizer consumption per hect. (Rs.)	Percentage area under	
			Cost A_2 (Rs.)	Cost C_2 (Rs.)		Cost A_2 (Rs.)	Cost C_2 (Rs.)	Cost A_2 (Rs.)	Cost C_2 (Rs.)	Cost A_2 (%)	Cost C_2 (%)		Irrigation	HYV
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1.	Punjab	29·49	2736·68	4452·57	5008·08	2271·40	555·51	84·32	137·47	1·83	1·13	776·40	N.A.	N.A.
2.	Rajasthan	18·75	1813·76	3138·24	3948·35	2134·59	810·11	80·26	137·25	2·18	1·26	296·86	N.A.	N.A.
3.	Haryana	25·56	2433·80	4056·73	4332·89	1899·09	276·16	84·28	140·93	1·78	1·07	547·49	—	—
4.	Uttar Pradesh	22·60	2165·82	3679·69	4142·33	1976·51	462·64	79·74	135·65	1·91	1·13	499·47	—	—
5.	Madhya Pradesh	11·90	1142·75	2102·94	2645·08	1496·33	545·14	77·01	140·18	2·30	1·26	143·37	—	—
6.	Bihar	18·77	1433·17	3119·03	4240·75	2807·58	1121·72	67·46	140·07	2·96	1·36	231·42	—	—
7.	Himachal Pradesh	11·12	1078·24	2136·84	2484·00	1405·76	347·16	81·87	158·01	2·30	1·16	88·98	—	—

*Since the data for 1983-84 has not been finalised, the data for the year 1982-83 has been taken.

TABLE 3·3– *Economics of Jowar, Bajra and Maize Production*, 1983-84

Sl. No.	State	Yield per hect. (Kgs.)	Per hect. cost of cultivation		Gross output per hect. (Rs.)	Profit/Return over		Cost of production per qtl.		Output/input ratio with		Fertilizer consumption per hect. (Rs.)	Percentage area under	
			Cost A_2 (Rs.)	Cost C_2 (Rs.)		Cost A_2 (Rs.)	Cost C_2 (Rs.)	Cost A_2 (Rs.)	Cost C_2 (Rs.)	Cost A_2 (%)	Cost C_2 (%)		Irrigation	HYV
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	JOWAR													
1.	**Madhya Pradesh**	8·06	587·51	1146·33	1381·80	794·28	235·47	54·54	104·71	2·35	1·20	8·00	—	—
2.	**Karnataka**	9·70	716·15	1353·16	1919·21	1203·06	566·00	63·18	117·14	2·67	1·41	17·46	4·2 (1982-83)	—
3.	**Gujarat@**	6·71	904·64	1530·42	2119·51	1214·87	589·09	73·29	122·24	2·34	1·38	16·44	2·8 (1981-82)	—
4.	**Maharashtra@**	7·75	937·00	1651·25	1698·59	761·59	47·34	75·10	133·51	1·81	1·02	19·76	5·9 (1981-82)	—
	BAJRA													
1.	**Rajasthan**	4.21	277·03	732·57	991·95	714·92	259·58	45·94	116·50	3·58	1·35	1·49	4·0 (1982-83)	—
2.	**Haryana**	6.46	509·19	1332·25	1149·81	640·62	182.44	51·83	135·53	2·26	0·86	6·71	15·9 (1982-83)	—
3.	**Gujarat@**	12·44	1359·59	2297·70	2790·02	1430·43	492·32	85·21	142·23	2·05	1·21	30·85	8·9 (1981-82)	—
	MAIZE													
1.	**Himachal Pradesh**	14·16	923·81	2144·58	2632·51	1708·70	487·93	51·83	121·17	2·85	1·23	39·96	6·6 (1982-83)	—
2.	**Rajasthan**	12·30	863·52	2005·64	2573·76	1720·14	568·12	52·90	119·88	2·98	1·28	31·48	23·7 (1982-83)	—
3.	**Bihar**	19·25	1095·46	2751·64	3826·65	2731·13	1075·01	48·66	126·27	3·49	1·39	34·12	31·0 (1982-83)	—

@Since the data for 1983-84 has not been finalised, the data for 1982-83 has been taken.

TABLE 3·4—*Economics of Rapeseed & Mustard and Groundnut Production, 1983-84*

Sl. No.	State	Yield per hect. (Qtls.)	Per hect. cost of cultivation Cost A₂ (Rs.)	Per hect. cost of cultivation Cost C₂ (Rs.)	Gross output per hect. (Rs.)	Profit/Return over Cost A₂ (Rs.)	Profit/Return over Cost C₂ (Rs.)	Cost of production per qtl. Cost A₂ (Rs.)	Cost of production per qtl. Cost C₂ (Rs.)	Output/input ratio with Cost A₂ (%)	Output/input ratio with Cost C₂ (%)	Fertilizer consumption per hect. (Rs.)	Percentage area under Irrigation	Percentage area under HYV
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
RAPESEED & MUSTARD														
1.	Uttar Pradesh	8·15	1245·68	2750·56	4298·57	3052·89	1548·01	146·35	325·13	3·45	1·56	22·72	7·6 (1982-83)	—
2.	Assam	6·37	713·64	1964·39	2820·98	2107·34	856·59	110·11	308·42	3·95	1·44	1·97	—	—
3.	Rajasthan	7·58	813·51	2065·53	3147·72	2334·21	1082·19	103·68	267·31	3·87	1·52	5·46	7·3 (1982-83)	—
GROUNDNUT														
1.	Tamil Nadu	11·29	2166·97	3713·89	4181·00	2014·03	467·11	167·59	294·49	1·92	1·13	19·98	24·9 (1982-83)	—
2.	Karnataka	8·06	1366·71	2429·58	3570·49	2203·78	1140·91	161·07	282·94	2·61	1·47	15·45	14·1 (1982-83)	—
3.	Gujarat@	7·20	1455·31	2443·60	2703·02	1247·71	259·42	146·40	244·36	1·86	1·11	57·86	10.7 (1981-82)	—

@Data relate to 1980-81.

TABLE 3·5—*Economics of Gram and Arhar Production, 1983-84*

Sl. No.	State	Yield per hect. (Kgs.)	Per hect. cost of cultivation Cost A₂ (Rs.)	Per hect. cost of cultivation Cost C₂ (Rs.)	Gross output per hect. (Rs.)	Profit/Return over Cost A₂ (Rs.)	Profit/Return over Cost C₂ (Rs.)	Cost of Production per qtl. Cost A₂ (Rs.)	Cost of Production per qtl. Cost C₂ (Rs.)	Output/input ratio with Cost A₂ (%)	Output/input ratio with Cost C₂ (%)	Fertiliser consumption of per hect. (Rs.)	Percentage area under Irrigation	Percentage area under HYV
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
GRAM														
1.	Uttar Pradesh	10·88	1109·94	2450·17	3330·03	2220·09	879·86	95·96	209·00	3·00	1·35	3·84	1·57 (1982-83)	—
2.	Madhya Pradesh	6·43	706·78	1545·35	2079·86	1373·08	534·51	97·56	217·19	2·94	1·34	0·70	8·2 (1982-83)	—
3.	Haryana	4·37	663·61	1516·93	1614·12	950·51	97·19	139·56	319·27	2·43	1·06	0·10	39·3 (1982-83)	—
4.	Rajasthan	5·00	565·63	1218·93	1726·03	1160·40	507·10	99·46	211·93	3·05	1·41	1·52	18·7 (1982-83)	—
ARHAR														
1.	Karnataka	5·46	838·04	1513·95	2298·47	1460·43	784·52	138·99	262·46	2·74	1·51	8·81	0·5 (1982-83)	—
2.	Madhya Pradesh@	11·21	881·05	2215·07	3025·43	2144·38	810·36	77·40	183·30	3·43	1·36	14·9	0·2	—

@Data relate to 1981-82

TABLE 3.6 —*Economics of cotton and Jute Production*, 1983-84

Sl. No.	State	Yield per hect. (Kgs.)	Per hect. cost of cultivation		Gross output per hect. (Rs.)	Profit/Return over		Cost of production per qtl.		Output/Input ratio with		Fertilizer consumption per hect. (Rs.)	Percentage area under	
			Cost A_2 (Rs.)	Cost C_2 (Rs.)		Cost A_2	Cost C_2	Cost A_2 (Rs.)	Cost C_2 (Rs.)	Cost A_2 (%)	Cost C_2 (%)		Irrigation	HYV
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
COTTON														
1.	Karnataka	15·45	3217·60	5581·29	10407·45	7189·85	4826·16	199·49	357·02	3·23	1·86	120·18	10·7 (1982-83)	—
2.	Madhya Pradesh . . .	3·12	878·67	1589·11	1679·26	800·59	90·15	279·34	508·89	1·91	1·05	18·60	9·4 (1982-83)	—
3.	Punjab	5·44	1822·33	3443·70	2900·84	1078·51	(—)542·86	314·38	593·47	1·59	8·42	54·49	97·5 (1982-83)	—
JUTE														
1.	Bihar	9·73	816·02	1981·24	2769·33	1953·31	788·09	75·70	183·80	3·39	1·39	1·86	—	—
2.	Assam	14·13	1175·59	3049·37	2726·10	1550·51	(—)323·27	75·03	195·46	2·31	8·93	—	—	—
3.	Orissa	20·38	1246·73	3252·64	5407·15	4160·42	2154·51	55·57	145·32	4·33	1·66	12·22	—	—
4.	West Bengal . . .	18·95	1951·53	4218·96	5786·75	3835·22	1567·79	91·52	198·45	2.96	1·37	27·69	—	—

TABLE 3.7—*Net Profitability of Competing Crops in Selected States*

State/Crop	Years	Cost A_2 (Rs./ha.)	Cost C_2 (Rs./ha.)	Gross value of produce (Rs./ha.)	Profitability over		Derived yield (Qtls./ha.)
					Cost A_2 (Rs./ha.)	Coat C_2 (Rs./ha.)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Andhra Pradesh							
Groundnut	1981-82 to	1618	2620	2585	967	(—)34	6·75
Paddy	1983-84	2825	4519	4856	2030	337	32·67
Assam							
Jute	1981-82 to	1077	2601	2432	1355	(—)170	12·95
Paddy	1983-84	763	1612	2405	1642	793	18·58
Bihar							
(a) Jute	1981-82 to	836	1876	2534	1698	658	10·17
Paddy	1983-84	1032	2472	3201	2170	729	18·51
(b) Wheat	1981-82	2521	6303	9921	7400	3618	22·33
Maize	and						23·75
Sugarcane	1982-83	2426	5807	10244	7817	4437	451·39
Gujarat							
(a) Jowar	1981-82 to	935	1582	2120	1185	538	6·71
Cotton	1982-83	2886	4246	4922	2037	677	8·13
(b) Bajra	1981-82 to	1381	1841	2967	1586	1126	12·44
Cotton	1982-83	2886	4246	4922	2037	677	8·13
Haryana							
(a) Gram	1981-82 to	604	1418	1406	803	(—)12	4·30
Wheat	1983-84	2270	3790	4244	1974	454	25·69
(b) Wheat	1981-82	2874	5208	5650	2776	442	25·69
Gram	to						4·30
Sugarcane	1983-84	2019	4677	7273	5255	2597	352·32
Karnataka							
Groundnut	1981-82	1355	2165	2630	1255	465	7·10
Ragi	and	1020	2028	2490	1470	461	11·44
Cotton	1982-83	2674	4019	5130	2457	1111	10·89
Madhya Pradesh							
Paddy	1981-82	848	1671	2020	1172	349	13·32
Jowar	and	610	1223	1306	696	83	8·60
Cotton	1982-83	921	1931	2826	1905	896	5·99
Maharashtra							
Cotton	1982-83	1427	2130	1860	433	(—)270	3·64
Jowar		937	1651	1694	757	42	14·12
Orissa							
Paddy	1981-82 and	1298	2917	3808	2511	892	15·43
Jute	1982-83	1111	2648	3416	2304	768	15·90
Punjab							
Cotton	1981-82 to	1726	3381	3744	2018	364	7·87
Paddy	1983-84	3767	5920	7084	3317	1164	54·00
Rajasthan							
Rapeseed & Mustard	1981-82 to	637	1590	2536	1399	946	6·16
Wheat	1983-84	1862	3242	4416	2554	1173	21·10
Tamil Nadu							
Groundnut	1981-82	3132	3480	3975	843	495	13·21
Paddy		3430	5191	5935	2505	744	39·17
Uttar Pradesh							
(a) Wheat	1982-83 and	2241	3736	4384	2144	648	23·31
Rapeseed & Mustard	1983-84	1130	2522	3794	2665	1272	7·93
(b) Wheat & Maize	1982-83	4164	7042	6582	2719	(—)159	24·03 14·10
Sugarcane		1997	4362	7952	5955	6311	401·75
West Bengal							
Paddy	1981-82 and	1820	3253	3506	1688	256	18·79
Jute	1982-83	1614	3267	3693	2090	427	16·09

CHAPTER IV

IRRIGATION AND CROPPING PATTERN

4.1 CHOICE of crops and cropping pattern in a region is governed by, *inter alia,* extent of available irrigation facilities and the prevalent water management practices. Availability of irrigation water induces the farmers to use more yield increasing inputs particularly fertilisers and high yielding varieties with the result that some crops become more profitable than others.

4.2 There is also a feeling that not only the availability but also the cost of irrigation water is an important determinant in the choice of crops. It would be, therefore, pertinent to examine how far the availability of irrigation has influenced cropping pattern in the past. This Chapter examines the impact of irrigation on crop production and cropping pattern as also the manner in which the cost of irrigation and water management practices can influence cropping pattern.

Changes in Irrigated Area and Crop Allocations

4.3 With the completion of the various irrigation projects in the country during different plan periods, as per land use statistics, irrigated area has increased from 22.5 million hectares in 1950-51 to 53.9 million hectares in 1983-84 or by about 31.4 million hectares. Unirrigated area during this period has increased relatively less *i.e.* by about 27 million hectares. The cropwise allocation of this additional irrigated and unirrigated area during this period is given in Table 4.1.

4.4 It would be seen that there were marked variations in cropping pattern in irrigated and unirrigated areas (Table 4.1). During the Fifties, the paddy crop accounted for about 40 per cent of the total irrigated area in the country. Other major crops which accounted for substantial irrigated area include wheat, barley, gram, amongst foodgrain crops and cotton and sugarcane among non-foodgrains. With the extension of irrigated area, there has been shift in the share of various crops in the irrigated area. As per 1983-84 statistics, paddy accounted for about one-third of the total irrigated area and almost a similar proportion was accounted for by wheat. Amongst non-foodgrain crops sugarcane, cotton, potato, fruits and vegetables account for significant proportions of the irrigated area. As against this, cropping patterns in unirrigated areas are pre-dominated by paddy Millets like jowar, bajra and maize, which together account for less than 5 per cent of the irrigated area but cover about one-third of the total unirrigated area. Pulses account for another 20 per cent as against about 3.5 per cent of the irrigated area.

4.5 Oilseeds account for substantial proportion of unirrigated area as against its relatively small proportion in irrigated area. Proportion of area occupied by sugarcane was more in irrigated conditions than under unirrigated conditions.

4.6 Of the total addition of about 31.4 million hectares to the irrigated area during the period from 1950-51 to 1983-84, about 14.5 million hectares (46.2 per cent) were accounted for by wheat. Another 7.6 million hectares or about 24 per cent of the additional irrigated area was devoted to rice. Thus, over 70 per cent of the additional irrigated area during this period has been devoted to production of cereal crops. The commercial crops, which have gained in irrigated area are sugarcane, cotton, fruits and vegetables and oilseeds. These crops have acquired between one to two million hectares each of the additional irrigated area during this period.

4.7 Millet crops of jowar, bajra and maize together have gained only one million hectares in all out of the total additional irrigated area of 31.4 million hectares *i.e.,* about 3 per cent. Irrigated area under pulses during this period actually declined, as also under ragi and barley.

Irrigation and Productivity

4.8 The major benefit of irrigation in agricultural production is in terms of increasing the physical productivity of land. It is difficult to isolate the contribution of irrigation to increase in productivity since the application of irrigation water is also accompanied by use of fertilisers and other additional inputs including improved varieties of seeds. However, since the use of other yield increasing inputs, particularly fertilisers and high yielding varieties of seeds, is not profitable in the absence of irrigation facilities, the entire difference in the yield rates under irrigated and unirrigated conditions may be considered as the contribution of irrigation associated with other inputs.

4.9 Data on yield rates of irrigated and unirrigated areas at the all-India level are not available. However, yield rates under irrigated and unirrigated areas for principal crops in major growing States are

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available. Based on available information on yield rates of irrigated and unirrigated areas for different States, weighted average of irrigated and unirrigated yield rates were worked out for 1983-84, which are presented below :

Yield Rates of Major Crops in Irrigated and Unirrigated Areas (1983-84)

Crop	Yield rates in Kgs. per hectare	
	Irrigated	Unirrigated
Rice	1636	1079
Jowar	1141	425
Bajra	1339	580
Maize	2268	857
Wheat	2220	964
Gram	698	632
Groundnut	1075	617

4.10 It would be seen from the above table that yield rates in irrigated areas were significantly higher than in unirrigated areas. Yield rates were more than double in the case of millets and wheat in irrigated areas as compared to that in unirrigated areas, whereas these were almost 50 per cent higher in case of rice and groundnut. Irrigation does not play any significant role in influencing productivity of gram. There is also evidence to support that in case of rapeseed & mustard, sugarcane and cotton, yield rates are much higher in irrigated areas as compared to unirrigated areas. These variations in productivity clearly bring out the role of irrigation in raising yield of certain crops.

Major Issues in Irrigation

4.11 Irrigation projects, at the formulation stage, usually envisage certain crop pattern and productivity levels. The extent to which these targets are achieved during the implementation of different irrigation systems needs to be examined. The deviations in the existing pattern from the envisaged one and the reasons therefor, will throw light on what could be the optimal cropping patterns in the command, given the availability of irrigation water.

4.12 This Group would command that socially optimal cropping pattern should take into consideration the social requirements and overall plan targets at the State and lower levels. In this context, the national priorities and targets for increasing oilseeds and pulses production should receive due consideration in developing/suggesting optimum cropping pattern. Since the availability of irrigation and water management practices influence changes in cropping pattern to a large extent, a study was commissioned by us to study this relationship in depth in some selected irrigated projects.

Cropping Pattern Study in Irrigation Command Areas

4.13 The above cited study on cropping patterns in selected irrigation commands, was carried out by the Operations Research Group (ORG) Baroda in 11 large irrigated projects. The basic objectives of the study were as under :

(i) to analyse the past changes and present trends in cropping patterns in irrigated command areas ;

(ii) to identify crops and crop combinations that can be promoted taking into account water and land use efficiency criteria, keeping in view national priorities for allocation of crop acreage particularly to oilseeds production, and

(iii) to examine how far can irrigation and water management influence the changes in cropping pattern.

4.14 This was a quick study conducted in a period of about three months. In spite of this constraint, the study could examine the general trends with regard to changes in cropping pattern, water management practices and also the factors considered important to promote certain desirable crops and crop combinations in each of the irrigated commands. The observations and conclusions of this study were examined by the Group and are briefly given in the following paragraphs.

Envisaged and Actual Cropping Patterns

4.15 A major conclusion which emerges from ORG's analysis is that crop diversification as envisaged at the time of formulation of various irrigation projects has not actually come about except in the IGN project. In 6 of the projects studied by the ORG, 44—91 per cent of the gross irrigated area was under kharif rice. Wheat was the next important crop accounting for more than 25 per cent of the gross irrigated area in 5 projects. Paddy and wheat together accounted for between 60 per cent and 95 per cent of the gross irrigated area in 8 projects. Other crops which featured significantly in the Command area were sugarcane and summer groundnut in Jayakwadi and gram, guar and mustard in IGNP. Table 4.2 compares the current crop acreages (1984) with those envisaged at the project formulation stage.

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4.16 The important factors which were responsible for this phenomenon included small land holdings predominating in majority of projects which prompted farmers to grow staple food and risk-free crops, absence of high yielding varieties, particularly of pulses and oilseeds and a general reluctance to, or a very low process of adoption of new crops by the farmers. In view of the low coverage under new crops, organised market support and supply systems for necessary inputs could also not develop. High prices of such crops reported in market centres were not actually realised by individual farmers in all corners of the command. The absence of support prices for most of the new crops and inadequate extension efforts to promote them were other inhibiting factors.

4.17 Other factors responsible for cropping pattern in surface irrigation system being different from what were planned include :

(i) Plentiful water availability in upper reaches of the distribution system in initial years of project which encouraged paddy pre-empting the rights of farmers down-stream.

(ii) Water logging close to canals and branches in upper reaches due to seepage.

(iii) Inability of the irrigation authorities to deliver water according to requirements of crops in the projected cropping patterns.

(iv) Prolonged kharif season due to dependence of sowing on first substantial rains, in many case aggravated by non-availability of short duration varieties. This pushed back the rabi sowing, thereby narrowing choice of rabi crops.

(v) Pre-emptive action on the part of farmers in the upper reaches by starting a second crop, often paddy, at the end of their early kharif crop or by cultivating perennial crops like sugarcane.

Water Management in Command Areas and Cropping Pattern

4.18 Water management in command areas is an important determinant of cropping pattern in the irrigation systems. The various management activities relate to the status of water availability, water release, distribution and utilisation. The study in irrigation commands has shown that in most of the projects, inefficient water management has not only led to problems like water logging and soil salinity but have influenced to some extent emergence of cropping pattern different from the one envisaged under a project.

4.19 A brief idea about the typical water management aspects, in projects studied is presented here.

A. Source of Water

4.20 All the irrigation projects studied are surface water projects. However, in some areas of Bhakra Nangal Dam Project (Sirhind Canal Region) ground water has been integrated into surface canal system to augment the water resources availability. The Indira Gandhi Nahar Project (IGNP), Tungabhadra Project (TBP), Bhakra Nangal Project (BNP), Gandak Project (GP) are inter-state in nature, where the water availability at the head-works is regulated by an inter-state Board. In projects like Sharda Sahayak and Mahanadi Delta, the river flow is diverted through barrages and the supply is continuous from the head works. In projects where the reservoir storage is also earmarked for power generation like BNP, TBP *etc.*, the canal releases are controlled by canal operating rules which give weightage to both power and irrigation needs.

B. Water Allocation

4.21 Water allocation to different regions/crops in a system is an important aspect of management. However, allocation policy of a command is influenced by the location and climatological factors as well as availability of water. In some projects due to limited water availability, the project authorities have attempted to evolve a water allocation policy for distribution of water within the command area. In IGNP a rotational water delivery system is arranged for group of canals which consist of allocating priorities for canal head supplies. The canal can be operated at its full rated capacity or partially or closed depending upon the priority assigned to that fortnight. The rating changes cyclically each fortnight among canal groups.

4.22 In Nagarjunasagar Project the command area is divided into different zones. In each zone the area is localised for wet (Paddy) cultivation or irrigated dry crops. The water is allocated in different periods to different zones and localised areas. The continuous and intermittent running of canals is carried between zones during different time periods. In Tungabhadra Project also the localisation of the command area into wet and dry crop regions is followed and water is allocated according to the demands of these areas.

4.23 In Bhakra Nangal Project water distribution to various parts of the command area is contributed by water allocation and the capacity factor of the major canals.

4.24 In case of barrage based projects like Mahanadi **Delta Project and Sharda Sahayak, the water** allocation is based on diversion at the head works and the flow is diverted continuously in the entire command areas.

4.25 Water allocation, in most of the projects, is decided by a committee comprising of officials from Command Area Development Authority Irrigation Department, Agriculture Department and Farmer's representatives.

C. Farmer Level Water Distribution

4.26 This aspect of management of irrigation water is most important for determining the allocation of area to different crops. Study of selected irrigation commands showed that in most projects a deficiency was observed in the extent of OFD net work. The canal net work maintenance was not proper leading to excessive seepage and operational loss.

4.27 There was inequitable distribution of water between head and tail reaches of the command area. The problem of inequitable distribution to some extent resulted from emergence of paddy as a principal crop in the head reaches. The case of Nagarjunasagar Project is an excellent example of this phenomenon. In this case due to availability of larger volume of water to the head reaches in the initial years of canal operation there was widespread cultivation of paddy even in the areas earmarked for irrigated dry crops. This deviation in the cropping pattern has stabilised over the years causing inequitable water distribution.

4.28 The trend in many projects is to have RWD systems based on warabandis pattern where farmers are assured of timeliness and quantity of water in relation to their farm size irrespective of their crop sequence. This system is evident in IGNP, BNP, Jayakwadi Project and Sharda Sahayak Project.

4.29 In Tawa, Gandak, Mayurakshi and Mahanadi Projects, the water is supplied on demand from the farmers. However, for kharif season, generally water is released continuously depending upon water availability and no predetermined system of water distribution to farmers has been observed.

Major Observations about Existing Cropping Pattern in Irrigation Commands

4.30 The study of the selected irrigation commands revealed that :

(i) The current trends in the irrigated cropping pattern appear to be in favour of paddy-wheat combination. Paddy has become a major crop in six out of eleven projects. In the projects located in high rainfall zone like Mahanadi Delta and Mayurakshi, paddy has become dominant crop as a consequence of prevailing soil, rainfall and climatological factors. In Projects like Nagarjunasagar, Tungabhadra and Bhakra Nangal, paddy crop has displaced other envisaged crops.

(ii) Emergence of paddy as the dominant crop with high water requirements in these projects has resulted in lower irrigation intensity than planned.

(iii) Wheat is another crop which has emerged as the dominant crop not only for rabi season but in overall cropping pattern as reflected by proportion of irrigated wheat area to gross irrigated area. Except for projects in the Southern India, paddy and wheat together accounted for between 60—95 per cent of the gross irrigated area in seven out of eleven projects.

(iv) Cotton, though envisaged as a major crop in quite a few projects, has not emerged as a significant crop, except in Tungabhadra and IGNP.

(v) Sugarcane has a regional bias being a major crop in Jayakwadi and Ukai-Kakrapara project, being predominant in the latter project. Because of its higher water requirements it has to compete with paddy, as major kharif crop.

(vi) Other crops which have a significant presence in different projects are Gram, Guar, Mustard (IGNP), chillies (NJP) and summer groundnut (Jayakwadi). Potato has also emerged as an important crop in specific zones in some of the project commands.

(vii) Pulses have not been observed to attract significant irrigated area in any of the projects.

(viii) The observations/analysis of the cropping pattern in selected projects shows that the phenomenon of crop diversification as envisaged in the original project formulation has not been achieved in most of the projects except in IGNP. Important feature of this deviation in the cropping pattern is the less predominance (or absence) of crops which are efficient from the point of view of returns per unit of water like maize, gram, pulses, vegetables, groundnut, sesamum and soyabean.

Desirable Shifts in Cropping Pattern in Command Areas

4.31 Taking into consideration the deviations from the envisaged cropping pattern in most of the irrigation commands and the imbalances in demand and supply of certain agricultural commodities like oilseeds and pulses *etc.*, it is desirable to promote larger acreage under these crops with appropriate technology and water management practices.

4.32 Promotion of different cropping patterns in various irrigation commands should be based on considerations of (i) high return per unit of water to improve the efficiency of irrigation sytems and (ii) national priorities for raising production of oilseeds, pulses *etc.*, to meet the demand.

4.33 The Group examined existing cropping pattern in different projects, water availability, farmers behaviour *etc.*, in some detail and would like to make the following recommendations.

4.34 Projects which have limited canal water availability, like Tungabhadra should give high priority to the promotion of kharif-rabi crop combinations with gram or wheat or any oilseeds. This will provide additional returns to farmers and lead to more efficient water use.

4.35 Production of oilseeds and pulses has not been keeping pace with increasing demand. Greater efforts are, therefore, needed to increase their production both through expansion of area and raising productivity. In view of the national priorities, it is suggested that crops like mustard, soyabean and safflower should receive special attention.

4.36 Taking into consideration the yield, productivity and return from paddy, it would be difficult to replace this crop in most of the project areas. However, desired changes and shift in cropping pattern even in those areas could be effected by appropriate policies and programmes. Promotion of short duration paddy (in paddy dominated projects) and also short duration pulses like urad and moong would help in improving cropping pattern and water utilisation.

4.37 Promotion of vegetables should also be encouraged in irrigation projects with limited canal water availability. This will contribute to more efficient use of water and attractive return to farmers.

4.38 In order to promote higher acreage under the desired crop combinations in the project areas, alternative strategies could be considered. One of the alternatives could be that a new or a minor crop could be propagated among certain category of farms *e.g.*, medium-large or large farmers can be persuaded to grow the suggested crops along with other major food and non-food crops.

4.39 The other alternative would be to promote such crops on an extensive scale covering specific geographic zone considered more efficient from soil-climatic point of view.

4.40 In order to promote desired crops suitable incentives or disincentives could be considered. For promoting certain crops incentives like price support, input subsidies, marketing facilities *etc.*, may be effective. Similarly, suitable disincentive particularly to discourage water intensive crops, which do not give adequate return per unit of water would have to be identified. Some such measures are discussed below :

(a) A national policy to identify areas/projects where paddy is prominently suitable should be formulated. Measures for discouraging paddy in new projects or those in early stages of development, in areas lying outside the identified potential area for rice, should be examined. Similarly, a national policy for encouragement of oilseeds (both irrigated and unirrigated), in identified areas with good potential through provision of both incentives and support should be framed.

(b) A good number of crop mixtures with oilseeds are available. Suitable crop mixtures of oilseeds with cotton, wheat *etc.*, should be identified for different regions/projects and propagated.

(c) Good technology in terms of quality seed, input practices *etc.*, available in the Lab for crops like oilseeds and pulses, should be disseminated to the field expeditiously. These available technologies need to be brought closest to the farmers environment through a more intensive extension effort.

(d) Producers of oilseeds and pulse crops are generally small and marginal farmers. Marketing support in various forms like collection of small volume of produce from farmers at predetermined price should be provided. The role and operations of NAFED for this purpose should be expanded to ensure farmers receiving support prices, particularly during harvest season.

4.41 There could be various other economic and technological strategies for accelerating production of favoured crops. These have been discussed in respective chapters of this Report. Policies relating to irrigation water management including irrigation rates which could influence crop acreaes are discussed below :

Irrigation Water Management

4.42 Irrigation water management is essential for the development of desired cropping pattern in the command areas. Water management is an important input for the development of high value crops in the command areas in both head and tail reaches. It is also a pre-requisite for improving crop productivity with reference to water utilisation. More importantly improved water management is necessary for ensuring quality and reliability in irrigation delivery system.

4.43 Water management practices in irrigation commands during kharif for (a) low rainfall and (b) high rainfall areas would be different. Some aspects of irrigation water management with the larger objective of improving the overall irrigation delivery system, which are expected to influence both directly and indirectly, the future cropping pattern are discussed below :

A. High Rainfall Areas

4.44 These are areas of large flows into the source of surface water for irrigation, on account of which there is waste of water through the canal systems, which often causes degradation of soil. Water that can be diverted from the rivers also often goes unutilised. Even in storage projects water not used in the middle of the season may be lost by overflow at the reservoir, later in the season.

4.45 The usual farmer response in this situation is to irrigate only paddy and not adopt high yielding technology, in apprehension of irrigation not being received as required (usually in excess, but often not available when needed). Under this situation for proper irrigation water management, the following are recommended :

- (i) delineate special commands of homogenous rainfall, and establish cross regulators and other controls on main canals and major branches so that water can be supplied to any special command where rainfall is deficit.
- (ii) so work out canal system operation procedures that appropriate response is made to any developing pattern of rainfall deficit. It would be proper to develop an early warning system for drought situation so that the canal system is activated early enough to be able to carry water to the farthest reaches before the drought becomes severe.
- (iii) develop methods (perhaps computer based) to monitoring and anticipate rainfall deficit in the special commands.
- (iv) make on/off operations feasible in a system where field to field irrigation is practised, the chaks have to be reorganised so that the number of fields in a series is limited.
- (v) in case of storage projects, the benefits that could be obtained by carrying water in the reservoir over the dry season should be examined in depth so that assured irrigation can be provided for raising nurseries and for transplantation.

B. Low Rainfall Areas

4.46 Low rainfall areas are usually characterised by unreliable irrigation supplies in kharif under the concept of 'protective irrigation', which results in low rate of return per unit of water. In these project areas, farmers do not adopt high technology even for irrigated dry crops. Where rice is grown in upper parts of command, lower areas get little effective irrigation. In order to use irrigation water management as a tool for influencing cropping pattern, it is recommended that the number of irrigation turns that will be adequate to provide good irrigation to irrigated dry (ID) crops in most years should be worked out. An operational plan should be developed which takes into consideration a range of opening dates for each of the turns, with a well formulated procedure for determining the opening date for a turn on the basis of rainfall observed. The emphasis should be on anticipating occurrence of deficit conditions and pre-empting such occurence at the expense of some wastage of water. Rice cultivation should be restricted to low slope areas at the bottom of distributories and other laterals, with high ground water availability, fed by irrigation which makes it economic to pump ground water to supplement surface deliveries.

C. Rabi Irrigation

4.47 In case of rabi season, the practices considered for irrigation water management for both high and low rainfall areas are generally common. They are briefly enumerated hereunder :

(i) Irrigation in rabi should lay heavy emphasis on providing a high degree of assurance of supply to the farmer, in terms of quantum as well as distribution of deliveries during the season. In this regard it is recommended that

- (a) methods to assess, to a high degree of reliability, the surface water that will be available must be developed. Where sources are shared by two or more States, clear delineation of shares has to be made and discipline in observing the agreed plan for use of common resources, especially by the upstream States enforced.
- (b) Where power, generation is associated with the project, coordinated planning of operation for irrigation and power must be done. This requires considerable efforts at

improving operational planning in both power and irrigation sectors.

(ii) The method of deriving priorities, in practice in Punjab, Haryana, parts of Uttar Pradesh and Rajasthan and introduction of delivery irrigation in the face of uncertainty in water availability and poor communication is commended. Its greatest merit is that it ensures a fair measure of equity. One of the approaches could be to give assured supply according to a set schedule for tail-end areas and those needing a special treatment. For the rest of the command, making deliveries as close as possible to set schedules should be ensured. Such schedules should recognise variations in cropping patterns within the command.

Irrigation Water Rates and its Role in Influencing Cropping Pattern

4.48 Cost of irrigation as reflected by irrigation rates is one of the important factors influencing both optimal use of water as well as appropriate cropping pattern. Water requirements of different crops vary significantly from about 400 mm per hectare in case of bajra to over 2400 mm per hectare in case of paddy and sugarcane. Requirements of wheat and potato were also quite significant. The crops whose water requirement is over 1000 mm are regarded as heavy water duty crops whereas crops whose requirement is less than 1000 mm are low water duty crops.

4.49 Availability of water as well as water rates are important determinants of cropping pattern in a project area. Abundance of water, at reasonably low rates, induce the farmers to grow crops which are heavy water duty but are also remunerative.

4.50 The Group has examined in depth the water requirements and irrigation rates for different crops. The irrigation rates in different irrigation projects under study for selected crops are given in Table 4.3.

4.51 An examination of the irrigation rates and water requirements for different crops shows that in general there was some relationship between the high duty crops and higher irrigation rates and *vice versa*. But on the whole there was no relationship between the irrigation rates of different crops and related water requirements. If the irrigation rates could be linked with volumetric requirement of water for different crops, these could be made more rational. Further, if irrigation rates are linked with volumetric requirements of water for different crops, then farmers would be more cautious in their choice of crops and would go in for crops which have higher return to water. Low irrigation rates in relation to low water requirement of light duty crops particularly of oilseeds and pulses may induce the farmers to go in for such crops under irrigated conditions. It is, therefore, recommended that to develop socially optimal cropping pattern including light duty crops like pulses and oilseeds, irrigation rates should be linked with volumetric requirement of water.

4.52 It has been observed that there was a large range in the irrigation rates of the same crop under different systems. In other words there was significant variations in the crop specific water rates from project to project. For example, water rates for sugarcane varied from Rs. 67 per hectaré in Bhakra Nangal Project to Rs. 750 per hectare in Jayakwadi Project. Although in case of food crops the rates are not so high but the range of variation is quite significant. In case of paddy it varied from Rs. 37.50 per hectare in Mayurakshi Project to Rs. 143.20 in Sharda Sahayak Project. In case of wheat it varied from Rs. 13.60 in Bhakra Nangal Project to Rs. 143.20 in Sharda Sahayak Project. There are similar variations in case of other crops as shown in Table 4.3.

4.53 While it may be quite rational to have different irrigation rates in different systems because of variations in the cost of the project as also the operational differences but their economic implications needed to be studied. Irrigation cost is one of the important components of cost of production of crops and could be used as a lever to discourage the cultivation of high water duty crops where desired. However, very high rates of irrigation charges in certain regions may result in an overall high cost of production of commodities, which ultimately may result in demands for higher minimum support/procurement prices and an overall inflationery impact on the economy. However, at the same time irrigation rates should not be so low as to induce over-use of water resulting in problems of drainage and land degradation. There was a feeling that irrigation rates in certain projects were too low, and it was necessary to rationalise these rates. These should be such as to at least recover the operation costs of the irrigation system. There is need for an overall review of the irrigation rates of different crops in various projects so as to develop a more rationalised system of water rates with relatively low range in rates. Since the requirement of water of different crops would be different depending upon the rainfall and weather situations, a volumetric basis of water charges will lead to definite improvements in irrigation use efficiency.

Power Rates for Irrigation

4.54 Tubewells/pump sets as a means of irrigation, of late have become quite important. Area irrigated by tubewells/pump sets have increased from 4.4 million hectares in 1970-71 to 11.0 million hectares in 1983-84. While there is not much difference in the price of diesel for pump sets, there are large variations in the power rates for irrigation in different States.

4.55 It would be observed that in case of irrigation by tubewells, generally the rates for power were based on HP of the engine. In other words, a system of flat rates of power are to be paid by a farmer based on the size of his engine, irrespective of the crop grown. This has also led to adoption of high water duty crops by the farmers ignoring light water duty crops like oilseeds and pulses.

4.56 We examined this issue and feel that a more rational approach in case of power rates would induce the farmers to shift their cropping pattern in the desired directions. It was felt that if the rate for irrigation was linked with actual use of water instead of with the HP of the engine used, it may lead to more rational use of irrigation water.

सत्यमेव जयते

TABLE 4·1—*Cropping Pattern in Irrigated and Unirrigated Area*

Crop	1950-51				1983-84				Irrigated increased 1983-84 over 1950-51	% share of increased area
	Irrigated area	% of total irrigated area	Unirrigated area	% of total unirrigated area	Irrigated area	% of total irrigated area	Unirrigated area	% of total unirrigated area		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Rice	9844	43·63	21212	19·40	17430	32·32	24006	18·99	7586	24·18
Jowar	463	2·05	15091	13·80	648	1·20	15799	12·50	185	0·59
Bajra	336	1·49	9408	8·61	560	1·04	11263	8·91	224	0·71
Maize	369	1·64	2881	2·64	977	1·81	4883	3·86	608	1·94
Ragi	333	1·48	1921	1·76	278	0·52	2321	1·84	—55	—
Wheat	3402	15·08	6608	6·04	17886	33·16	6832	5·40	14484	46·17
Barley	1383	6·13	1815	1·66	658	1·22	735	0·58	—725	—
Other Cereals and Millets	248	1·10	5328	4·87	51	0·09	3668	2·90	—197	—
TOTAL CEREALS AND MILLETS	16378	72·59	64264	58·78	38488	71·36	69507	54·98	22110	70·47
Gram	974	4·32	6829	6·25	1027	1·90	6135	4·85	53	0·17
Tur	11	0·05	2217	2·03	86	0·16	3064	2·42	75	0·24
Other Puses	954	4·23	9569	8·75	605	1·12	12894	10·20	—349	—
TOTAL PULSES	1939	8·59	18615	17·03	1718	3·19	22093	17·48	—221	—
TOTAL FOODGRAINS	18317	81·18	82879	75·81	40206	74·54	91600	72·45	21889	69·77
Sugarcane	1183	5·24	574	0·53	2593	4·81	667	0·53	1410	4·94
Condiments & Spices	164	0·73	1080	0·99	855	1·59	1353	1·07	691	2·20
Fruits & Vegetables	102	0·45	2147	1·96	1963	3·64	3258	2·58	1861	5·93
Including root crops	—	5·74	—	0·02	—	0·20	—	—	—	—
TOTAL FOOD CROPS	20389	90·36	86707	79·31	45730	84·78	96850	76·61	25341	80·77
Cotton	465	2·06	5190	4·75	2271	4·21	5449	4·31	1806	5·76
Groundnut	75	0·33	4331	3·96	1277	2·37	6185	4·89	1202	3·83
Sesamum	41	0·18	19·16	1·75	133	0·26	1785	1·41	92	0.29
Rapeseed & Mustard	109	0·48	949	0·87	1277	2·37	1447	1·14	1168	3·72
Linseed	9	0·04	1217	1·11	18	0·03	1272	1·01	9	0·03
Other Oilseeds	8	0·04	1105	1·01	352	0.65	1277	1·01	344	1·10
TOTAL OILSEEDS	243	1·08	10725	9·81	3057	5·67	15249	12·06	2814	8·97
Tobacco	59	0·26	320	0·29	157	0·29	295	0·23	98	0·31
Fodders Crops	666	2·95	4783	4·32	1694	3·14	66·29	5·24	1028	3·28
Other Non-food Crops	—	3·30	—	2·63	—	1·91	—	4·13	—	—
TOTAL NON-FOOD CROPS	2174	9.64	22623	20·69	7547	13·99	30171	23·86	5373	17·13
TOTAL GROSS IRRIGATED AREA	22563	100·00	109330	100·07	53937	100·00	126424	100·00	31374	100·00

TABLE 4·2 *Envisaged and Actual Cropping Pattern (Irrigated)*

Season/Crops	IGNP (Stage I)		Gandak**		Bhakranangal		Jayakwadi		Tawa*		Ukai-Kakrapara	
	A	B	A	B	A	B	A	B	A	B	A	B
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
KHARIF												
Cotton	12·7	20·3			14	1·8	37·5	4·0	3·0	0·9	17·0	4·9
Paddy		1·8	58·5	46·0	4	30·4	5·0	1·9	22·2	0·5	17·7	15·9
Vegetables		0·4			1				0·7		3·0	0·5
Pulses		0.4							3.7			
Fodder	4·1	2·8			14	0·8			1·5			
Gawar		14·2			7	5·8						
Bajra		0·8			4							
Groundnut		1·7						0·8	3·7		3·4	0·0
Jowar								7·6	11·1	0·1	4·6	0·3
Soyabean										0·7		
Kharif Maize			2·6			7·7						
Jute			5·3									
Others	24·6	1·4						14·1			5·0	1·4
TOTAL KHARIF	41·4	43·7	66·4	46·0	44	46·5	42·5	28·4	45·9	2·2	50·7	23·0
RABI+H.W.												
Wheat	25·5	25·6	18·7	32·0	32	44·1		21·9	40·7	72·7	14·3	4·6
Gram		14·5						3·8	5·2	23·6		
Mustard	Oilseeds	11·9	Oilseeds		4							
Linseed	8·6		1·1	0·1								
Pulses		0·2	1·0	0·2			Rabi & H.W. seasonals		1·5	1·2		
									2·6	0·3		
Rabi Jowar					9	7·4		14·9			4·6	0·3
Fodder	4·1	1·4			5	0·5	53		0·6			
Vegetables		0·1			1				1·3		5·0	2·1
Groundnut								12·6			4·4	1.3
Paddy			5·1	3·5							5·2	11·6
Others	19·1	2·1	1·5	6·6				2·5			5·0	5·0
			R. Maize	R. Maize 5·7 Potato								
TOTAL RABI+H.W.	57·3	55·7	27·4	48·1	51	52·0		55·7	51·9	97·8	38·5	24·9
1. Sugarcane	1·3	0·6	5·4	5·9	5	1·5	3·0	14·9	2·2		10·8	49·6
2. Other perennial			0·8				1·5	1·0				2·5
Gross Irrigated Area (ha.)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
Ultimate Potential	5,84,000		11,52,000				2,83,000		3,33,000			

A—Envisaged cropping pattern.

B—Actual cropping pattern.

*Area irrigated by all sources in Hoshangabad District.

**Area irrigated by all sources in all districts coming under Gandak command.

TABLE 4·2—*Contd.*

Season/Crops	Nagarjunasagar A	Nagarjunasagar B	Tungabhadra A	Tungabhadra B
KHARIF				
Paddy	27·77	57·20	8·00	15·44
Hy. Bajra				7·07
Groundnut	8·90	1·55		5·09
Cotton	5·48	8·77		0·56
Hy. Maize			24·64	5·00
Pulses	8·22	1·15		
Jowar	11·30	4·54		
Others	0·68	0·60		9·58
TOTAL KHARIF	62·35	73·81	32·64	43·14
RABI				
Cotton		8·77	8·26	14·52
Rabi Jowar	9·93	4·54	53·31	6·99
Sunflower				5·34
Chillies	5·48	6·88		
Groundnut	8·56	1·55		
Others	13·00	4·06		6·51
TOTAL RABI	36·97	25·80	61·57	33·56
HOT WEATHER				
Paddy			0·0	12·10
Groundnut			0·0	9·05
Others			0·0	00·16
TOTAL H.W.			0·0	21·31
nials				
Sugarcane	0·68	0·39	4·04	1·99
Garden crops			1·75	0·0
TOTAL PERENNIAL	0·68	0·39	5·79	1·99

Season/Crops	Mayurakshi A	Mayurakshi B	Mahanadi A	Mahanadi B	Sharda ahayak	
KHARIF						
Cotton						
Paddy	91·7	89·2	40·5	51·5	33	15·0
Vegetables				4·3		
Pulses						
Fodder					2	5·26
Guwar						
Bajra						
Groundnut				0·3		
Jowar						
Soyabean						
Kharif Maize					18	0·09
Jute			13·5			
Others				3·4		
TOTAL KHARIF	91·7	89·2	54·0	59·5	53	20·35
RABI+H.W.						
Wheat		1·9	5·4*	0·7	24	61·05
Gram						
Mustard						
Linseed					5	0·52
Pulses			4·7	25·6**		
Rabi Jowar	8·3					
Fodder						
Vegetables		1·5			7	3·15
Groundnut				5·3		
Paddy			22·3	6·2		
Others		7·1		2·7		
TOTAL RABI+H.W.	8·3	10·5	32·4	40·5	36	64·72
Sugarcane		0·3	13·6		7	14·93
Other Perennial						
Gross Irrigated area (ha.) ultimate potential	239563 (100)	246493 (100)	536310 (100)	504170 (100)	(100)	(100)

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* Includes cotton & Groundnut also.

**Inclusive of vegetables (mostly taken up under retentive moisture conditions.)

TABLE 4·3—*Irrigation Water Rates in Different Irrigation Projects*

(Rs./ha.)

Crops	Indira Gandhi Nahar Project	Tawa Project	Jayakwadi Project	Gandak Project (Bihar)	Tungabhadra Project (Karnataka)	Nagarjuna-sagar Project	Bhakranangal Project	Sharda Sahayak Project	Mayurakshi Project
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
KHARIF									
Paddy	99	74	50 (fixed) 100 (demand)'	Kharif season 78·75	86·45	Rs. 100/ha.	48·20	143·20	37·50
Maize	45		Kharif seasonals —50		49·40		31·50	86·50	
Bajra	45								
Jowar	45	74 (HYV), 49 (Local)			49·40				
Pulses	52	59			37·05				
Guwar	52								
Vegetables	72				49·40				
Groundnut	57	49			59·28				
Other Kharif Crops	57	49			49·40		18·50	86·50	
RABI									
Wheat	74	124 (HYV), 84 (Local)	Rabi seasonals 75	Rabi season	54·34		13·60	143·20	Rabi seasonals 50
Barley	52	49		46·25					
Gram	72	59					13·60		
Jowar		111 (HYV), 74 (Local)			49·40				
Fodder	45	124					14·80	49·40	
Oilseeds	57	49							
Lucerne & Poppy	89								
Vegetables		296			98·80		40·80		
Paddy					98.80				
Other Rabi Crops	64	74 sunflower					40·80 (Potato)	177.80 (Potato)	
HOT WEATHER									
Paddy		222	Summer seasonals	Summer Season 138·75					125
Pulses		59	150				18.50	106·20	
Groundnut			300		59·20				
Two Seasonal Cotton*	89	124 (HYV), 84 (Local)	400	As per season	98·80		38·90		
Perennial Sugarcane	143	296	750	As per season	370·50		66·70	237·10	
Garden Crops	180		750 (Banana)						
Pre-sowing Irrigation	22	49	25						

*Gram as kharif crop

**Needs to be confirmed officially.

CHAPTER V

PRICE POLICY AND CROPPING PATTERN

5.1 REMUNERATIVE and assured prices for agricultural produce are one of the three basic requisites for a sound agricultural economy, others being productive technology package, and efficient delivery services for inputs. It was in this perspective that with the introduction of modern farm technology in mid-sixties the Government simultaneously set up the Agricultural Prices Commission to advise on agriculture price policy and a purchase mechanism through Food Corporation of India.

Role of Agricultural Price Policy in Influencing Crop Production

5.2 While it is generally argued that higher prices for agricultural produce induce the farmers to invest in agriculture for increasing production and productivity, there is also a view that higher prices, beyond a point, are not a proper instrument for increasing production. Since the Government has been pursuing agricultural price policy for over two decades, it was felt desirable by the Group to analyse its role in influencing crop production.

5.3 The main objective of the Government's price policy for agricultural produce, pursued over the years, is to ensure remunerative prices to the growers for their produce with a view to inducing higher investment and production besides safeguarding the interests of consumers by making available supplies at reasonable prices. The price policy seeks to evolve a balanced and integrated price structure in the perspective of the overall needs of the economy. As part of the policy, Government announces each season procurement/support prices for major agricultural commodities and organises purchase operations through public/cooperative agencies such as Food Corporation of India, Jute Corporation of India, Cotton Corporation of India, National Agricultural Cooperative Marketing Federation (NAFED) and Tobacco Board besides other agencies designated by the State Governments.

5.4 Support/procurement prices are now being fixed and market support operations are undertaken for various commodities. Of these, rice, wheat, cotton, sugarcane *etc.*, are the crops for which the system of fixation of minimum support/procurement prices and provision of market support has been regular and continuous over a long period. For most of the other commodities, the price and market support operations were taken up at later stages. The agricultural price policy of the Government has played a positive role towards raising agricultural production in the country. Wheat and rice which were covered under the price support scheme right from the initial stage, have shown a high rate of growth of production of 5.70 and 2.38 per cent per annum, respectively. This has resulted in significant increase in production of total foodgrains from 87.8 million tonnes per annum during the triennium ending 1968-69 to 149.4 million tonnes during the triennium ending 1985-86. The production of other agricultural commodities like oilseeds, sugarcane, cotton, jute and mesta have shown considerable increases during this period. The increase in production of different agricultural commodities between the triennium ending 1968-69 and the triennium ending 1985-86 is shown in Table 5.1.

5.5 It was observed that since 1967-68 (mid-year of the base period) agriculture production has increased by over 69 per cent during a period of 17 years. While rice production has gone up at almost the same rate as the overall agricultural production, wheat production during this period has increased almost three times. Production of sugarcane, cotton and jute has increased by about 67, 44 and 57 per cent, respectively. The overall performance of agricultural production as well as that of production of major crops does indicate that agricultural price policy has made a positive impact in increasing production.

5.6 Another way of examining the role of agricultural price policy in the development of agriculture is its impact on overall agricultural investments and use of inputs. Investments in farm assets including tubewells, tractors as also higher use of yield increasing inputs like fertilisers, plant protection chemicals *etc.*, lead to increases in productivity. An examination of the data relating to growth in the number of tractors, tubewells, fertiliser consumption and plant protection chemicals as given in Table 5.2 shows that there has been considerable step up in input use. Number of tubewells in the country has increased from 4,30,000 in 1967-68 to 64,63,000 in 1980-81, with the result that the proportion of irrigated area contributed by this source to the total irrigated area increased from about 6 per cent to about 25 per cent. Number of tractors which was less than 6 per thousand hectares in 1967-68 increased to over 50 per thousand hectares in 1983-84. Fertiliser consumption during this period has increased by almost four times whereas the use of plant protection chemicals has reached the level of 6 thousand tonnes as against a negligible quantity in the sixties. These trends clearly show the increased level of investments and greater use of inputs in agriculture induced by the price policy followed by the Government. The yield per hectare of various crops has shown considerable improvement over the years. The yield index of all crops between the triennium ending 1968-69 and 1985-86 showed an increase of 50.9 per cent, which indicates that bulk (about 80 per cent) of increase in total agriculture production has come from increase in productivity. This was made possible mainly by the increase in the yields of paddy, wheat, jowar, sugarcane, groundnut and cotton of the order of 49.0, 96.4, 41.4, 27.7, 32.6 and 45.9 per cent, respectively. Taking into consideration the increase in agricultural production and productivity, it can be observed that agriculture price policy so far pursued by the Government has made a positive and significant impact on crop production.

5.7 Amongst various public policies, price policy is one of the important instruments to bring about shifts of agricultural resources from one crop to another. This shift may be required to balance the domestic demand and supply, export and foreign exchange considerations and other influences. This selective use of price policy through minimum support/procurement prices has every chance of bringing about the desired shift in cropping pattern.

5.8 Shift in profitability ratio with changes in prices would occur only if physical resource—product relationship remains static over time. This is illustrated with the following example.

5.9 If a farmer from his fixed resources can produce 9 quintals per hectare of gram or 18 quintals of wheat per hectare, and price of gram is just double that of wheat he will be indifferent as to whether he produces wheat or gram. Under these circumstances, even a small increase in the relative price of a commodity will change ranking in profitability and shift may take place in favour of the crop whose relative price has increased. However, in constrast, if a situation develops when technology is improved for wheat and the farmer is able to produce from the same resources 36 quintals of wheat per hectare with price ratio as above, it would require a very large relative increase in price of gram to bring about shift of area in its favour from wheat. In fact this situation has developed in Indian Agriculture after the introduction of dwarf high yielding varieties for wheat. It is, therefore, essential that while considering price policy, the relationship between the productivity ratios of competing crops, say, Y_2/Y_1 and their price ratios *i.e.*, PY_1/PY_2 is taken into account.

Reducing Price Uncertainty

5.10 Price uncertainty has an important effect on the level and pattern of crop production. In many cases price fluctuates in a most irregular and unpredictable manner. Thus, among crops with different degrees of uncertainty, regarding prices, the one which has greater uncertainty will be given lower preference. In India there are many crops whose prices fluctuate quite considerably in the absence of effective marketing support and this factor is responsible for their low share in area allocated. For example, wheat and paddy have been provided continued price support and their production has shown a sustained growth as against pulses, whose prices have a tendency to fluctuate more and have not been getting adequate market support. Thus, if it is desired to increase production of commodities which experience considerable price uncertainty, more effective price and marketing support for such crops will have to be provided in relation to other crops.

5.11 Another problem associated with large fluctuations in prices and imperfect markets is that speculative traders tend to exploit the situation and charge the consumer far more than the price justified to cover the cost of storage and finance. In the circumstances, the maintenance of certain stability in prices might be considered necessary to protect the vulnerable sections of the population from profitering.

Inter-Crop Price Parity and Shift in Cropping Pattern

5.12 The changes in value productivity obtained as a product of yield and support/procurement prices (gross income) per hectare of principal crops in India during the period 1970-71 to 1985-86 are shown in Table 5.3. It would be seen that the gross income per hectare from crops like wheat, paddy, sugarcane, potato *etc.*, was not only higher in the base period but has increased at a much higher pace than that from coarse cereal crops like jowar, bajra, maize and pulses *viz.*, gram, urad, moong *etc.* Coarse cereals and pulses have not been able to maintain parity in gross income with superior cereals like rice and wheat with the result the area from these crops has shifted to other crops. Therefore, if certain changes in the cropping pattern are desired to be effected through pricing policy, parity in income from different crops needs to be considered.

Technology Versus Price Policy

5.13 Very often, it is argued that the prices of certain agricultural commodities should be raised substantially if we want to step up their production. However, in actual practice this has not happened in many cases particularly when there are technological advantages in other competing crops. Prices of pulses and oilseeds have been substantially increased relative to other competing crops in recent years yet growth of the desired level in their production has not been achieved. We might consider increase in productivity as a measure of development of technology and study the changes in ratios of yield *vis-a-vis* ratios in support prices between the competing crops.

5.14 Whereas price ratios of certain pulses and oilseed crops with respect to their competing crops has increased over time, these ratios were not higher than the inverse productivity ratios of these crops. It has been observed that price ratio of gram and wheat has increased from 1.25 to 2.0 but their inverse productivity ratio has increased from 1.5 to 3.0 during this period. This shows that whereas increase in prices of gram was much higher than that of wheat during this period, increase in productivity of wheat was higher still with the result that wheat has become more profitable. This shows that prices by themselves have a limited role in increasing agricultural production and effecting shift in cropping pattern unless they are supported by technological development. In the absence of appropriate technological advancement even the relatively higher increase in the prices of oilseeds and pulses have not resulted in any significant increase in area and production of these crops. It may not also be desirable to raise the prices of these crops to the extent of neutralizing the technological advantage of the competing crops, as it would deprive the society of the gains from productivity improvement and cause a price spiral. It is, therefore, recommended that agricultural price policy must not be considered in isolation for bringing about changes in cropping pattern but must be viewed in relation to supplementary changes in technology and crop husbandry. Besides gains from international trade have also to be taken into account while fixing the prices of competing crops.

Price Spread and Price Support

5.15 Price spread is an important indicator of efficiency of marketing and price policy. An effective price policy should not only reduce uncertainty arising from seasonal fluctuations, but also minimise the price spread. In case of high price-spread, even a higher price paid by the consumers may not benefit the producers as a large part of it would be appropriated by the middlemen and other market functionaries. In order to induce the farmers to grow a particular crop, it is essential that they are assured of a fair share of the price paid by the consumers for their produce.

5.16 Producer's share in consumer's price is relatively higher in surplus regions because of the well developed market infrastructure. In the case of wheat in Punjab the producer's share in consumer's price is over 80 per cent. In case of rice, this share in Punjab is higher than in other leading rice-growing States. In the case of oilseeds and pulses, the producer's share in consumer's price tends to be lower because of inadequate market infrastructure and ineffective public intervention by way of procurement, especially in the less developed regions. This aspect has been examined at some length in the report of the Study Group on Agricultural Price Policy for Balanced Development of Agriculture set up by the Planning Commission.

5.17 The Group is of the view that mere fixation of minimum support prices of commodities and occasional market intervention when market prices fall below the minimum support prices do not serve the basic purpose. It may help check the prices from going below a minimum level, but may not help the farmers to get their due share. In the absence of government intervention and market support, traders exploit market situation by buying commodities at relatively lower prices in the peak marketing season and selling them at abnormally high price to the consumers during the lean season. This is the situation particularly in case of oilseeds and pulses. In order to overcome this situation and reduce the price spread for these commodities, it is recommended that market support operations should be taken up for these commodities on a regular basis as in case of superior cereals of rice and wheat. A proposal for buffer stock operations in edible oilseeds/oils also needs to be considered.

5.18 In case of crops where a large scale technological break-through has taken place showing a sharp increase in productivity, the increase in prices will have to be relatively less to maintain parity in incomes of different crops particularly with those where there is no such technological breakthrough. In order to attain the desired cropping pattern it may, therefore, be necessary to provide a more favourable price for crops for which no technological breakthrough has taken place.

TABLE 5·1—*All-India Production of Selected Crops for Triennium ending 1968-69 and 1985-86*

(In thousand tonnes/bales)

Crop/Year	Production		Increase in Triennium Ending 1985-86 over Triennium Ending 1968-69	
	Triennium Ending 1968-69	Triennium Ending 1985-86	Absolute	Per cent
Rice	35937	60862	24925	40·95
Wheat	15528	45477	29949	65·86
Coarse Cereals	26011	30515	4504	14·76
Total Cereals	77476	136854	59378	43·39
Total Pulses	10289	12607	2318	18·39
Toal Foodgrains	87765	149461	61696	41·28
Groundnut	4924	6356	1432	22·53
Rapeseed & Mustard	1381	2771	1390	50·16
Total Oilseeds	7361@	12264	4903	39·98
Cotton (lint)	5497	7835	2338	29·84
Jute	4870	7936	3066	38·63
Mesta	1133	1477	344	23·29
Sugarcane	104334	172025	67691	39·35

@Relates to seven oilseeds *i.e.*, Groundnut, Castorseed, Sesamum, Rapeseed & Mustard, Linseed, Safflower and Nigerseed.

NOTE.—Cotton, Jute and Mesta are given in thousand bales.

TABLE 5·2—*Progress in Use of Tractors, Tubewells, Fertilisers and Insecticides/Pesticides*

Year	Tractors (in '000 Nos.)	Tubewells (in '000 Nos.)	Fertiliser (in lakh tonnes)	Insecticides/ Pesticides (in '000 tonnes)	Net sown area per tractor (in hectare)
(1)	(2)	(3)	(4)	(5)	(6)
1960-61	31·0	430·0	2·92	8·62	4296·8
1965-66	54·0	886·0	7·84	14·48*	2522·2
1970-71	148·2	2175·0	21·77	24·32	949·9
1975-76	275·9	4798·4	28·94	33·08*	513·1
1980-81	479·0	6463·0	55·16	45·00	292·9
1985-86	849·0		87·37	52·00	194·8**

*Figures are projected using the growth rate for the period 1965-66 to 1970-71 and 1970-71 to 1980-81, respectively.

**This figures is completed using the Forecast Area for 1985-86.

TABLE 5·3—*Value Productivity of Principal Crops*

(Rs. per hectare)

Year	Paddy	Jowar	Wheat	Gram	Groundnut	Sugarcane	Cotton	Jute
1970-71	775	256	993	623	709		367	1271
1971-72	907	253	1049	681	700		524	1429
1972-73	867	269	966	1061	585		541	1472
1973-74	1208	380	1231	1066		4093	723	1765
1974-75	1165	476	1405	1191		4238	944	1514
1975-76	1371	437	1480	636	994	4327	867	1845
1976-77	1208	493	1526	646			953	
1977-78	1511	547	1658	814	1124	4774	1204	1706
1978-79	1693	602	1803	1043	1300	4916	1283	1975
1979-80	1530	664	1680	697	1380	6170	1320	2030
1980-81	2104	693	2120		1400	7520	1395	1992
1981-82	2256	843	2401		2006	7586	1912	2590
1982-83	2253	752	2742	1680	2130	7337	1854	2552
1983-84	2884	899	2801	1591	2375	7556	1688	2621
1984-85	2912	929	2936		2437	8074	2378	2751
1985-86	3340	833	3296	1932	2558	9898	2461	3691

CHAPTER VI

TECHNOLOGY AND CROPPING PATTERN

6.1 AFTER the introduction of modern technology *i.e.,* high yielding varieties for major cereals and hybrids for millets and with the use of chemical fertilisers and controlled irrigation water, there has been a significant increase in productivity as well as area under these crops. Land resources are generally fixed. However, the levels of material inputs used and technology are dynamic in nature and are an important determinant of farmers' decisions on allocation of area to various crop enterprises.

Components of Technology

6.2 Agricultural technology consists of varietal development (seed technology), levels of application of modern material inputs including chemical fertilisers, pesticides, weedicides, controlled irrigation water, package of practices as well as improvement of human skills. In other words, improved modern technology enables the farmers to increase yield per unit of his fixed land resource.

Variations in Level of Technology for Different Crops

6.3 The rate of development of technology as well as its diffusion amongst the farmers would be different for different crops. Technology of high yielding varieties for wheat was transferred to farmers at a much faster rate and to larger areas as compared to paddy as well as hybrids of millets. Besides, there are various socio-economic and agro-climatic factors that affect the rate of transfer of technology. Modernisation of agriculture through transfer of technology has to be accomplished taking into consideration the targets set for agriculture production in a long or medium term perspective. These factors would also influence the trends in cropping pattern.

Potential of Available Technology

6.4 The performance of agricultural production is influenced by the adoption of technology and the level of inputs used. . Even a high yielding variety when cultivated without proper and adequate use of inputs and recommended package of practices may not yield the desired results. Technology gives desired levels of production only when it is adopted in full, duly supported by the entire package of practices and resource use recommended. This situation is usually maintained under National Demonstrations. The yield obtained under these demonstrations would show the potential for increasing productivity under the available technology for different crops. The average yield of principal foodgrains crops in National Demonstrations in comparison with State averages under irrigated conditions for 1983-84 are shown in Table 6.1.

6.5 A comparison of yield levels under National Demonstrations and average yield in various States show that there exists tremendous potential for increasing yield of different crops although yield potential differs from State to State. In the case of paddy, average yield can be increased from 1.25 to 3.5 times in different States. It is the ICAR's view that on an average the productivity of paddy can easily be increased by about 50 per cent even if we are able to transfer the available technology to the extent of 75 per cent.

6.6 In the case of wheat, yield can be increased from 1.25 to 4.0 times the present level in major producing States. Similarly, ratios of average yield based on National Demonstrations and crop estimation surveys for maize, jowar and bajra vary from 1.20 to 4.0 times in different crops/States. On an average at the National level, the yield ratios based on National Demonstrations and crop estimation surveys for paddy, wheat, jowar, bajra and maize for 1983-84 were 2.21, 1.73, 4.79, 3.73 and 2.28, respectively. The differentials between average yields under National Demonstrations and according to general crop estimation survey shows the potentials upto which yields of different crops can be raised, provided available technology is transferred to farms through effective extension service supported by adequate and timely supply of inputs and necessary infrastructure.

Technological Gaps in Resource-Use

6.7 Irrigation coverage, fertiliser consumption and area under high yielding varieties are important components of modern technology in agriculture. However, levels of development and use of these resources have not been uniform across States or different strata of farmers. It is observed that there are considerable shortfalls in the actual application levels of these inputs as compared to the recommended levels. Yield levels of different crops can be raised considerably if use of these inputs is stepped up.

6.8 In case of irrigation, Punjab has taken the lead with the net irrigated area being 80 per cent of net area sown. On the other extreme line large States like Madhya Pradesh and Maharashtra where this ratio is less than 15 per cent. Associated with the irrigation facilities is the application of fertilisers. Inter-State comparison of fertiliser consumption for 1983-84 shows that it varied from about 2 Kgs. in Assam to 120 Kgs. per hectare in Punjab with an average consumption of 50 Kgs. per hectare. Variation in application of fertiliser were more marked than variations in the percentage of area irrigated.

6.9 The third important component of technology is high yielding varieties of seeds, use of which is influenced by the use levels of other resources particularly irrigation water. The use of high yielding varieties of seeds is confined, by and large, to rice, wheat, jowar, bajra and maize. Adoption of this component of technology across States also showed marked variations. The percentage of area of crops covered under high yielding varieties varies from 15 per cent in Nagaland to 85 per cent in Punjab. Variations in percentage of area covered under high yielding varieties of careals, is less marked than the variations in percentage of irrigated area. This may be due to the fact that high yielding varieties can also be profitably used under assured rainfall conditions.

Use of Technology in Efficient Environment

6.10 Crops are cultivated under wide range of situations varying from ideal to less favourable environments. Some of the main reasons for growing a crop in environments other than the best suited may be (a) necessity of meeting household requirement of the cultivator, (b) diversifying crops production to reduce risk and uncertainly, (c) non-availability of better alternative crops/technology, (d) lack of infrastructural facilities and (e) constraints of farm inputs including credit. Maximum returns to available technology can be attained only if it is applied in crop production under efficient environment. The ICAR, NCA and other agencies have identified agro-climatic zones and have recommended optimal crop patterns for each zone. The ICAR has also identified 'efficient' crop zones in a recent study for some principal crops based on the existing technology. This study indicates the new varieties of crops and crop combinations which could be considered as alternatives to the existing cropping pattern in selected areas.

6.11 This study, on identification of efficient crop zones relates to sugarcane, rice, wheat and maize crops. The analysis is based on a study of relative yield indices. Relative yield index was worked out as the ratio of average yields at the district level in relation to national yield whereas relative spread index was based on the ratio of area of the crop to total cropped area in the district in relation to percentage area of the crop to total cultivated area in the country. Assuming the average relative yield and spread index below 100 per cent as an index of relative inefficiency, the area under crops was divided into four categories as under :

(i) high spread, high productivity zone;

(ii) low spread, high productivity zone;

(iii) high spread, low productivity zone, and

(iv) low spread, low productivity zone.

6.12 Based on this analysis major producing States have been classified into above categories by the ICAR. Such a categorisation of States for comparing the yield rates might have some general validity but might not serve as a sound criterion for grouping them on the basis of efficiency. Crop production could be efficient only when productivity is higher in terms of resource use instead of in physical terms ignoring the quantity of inputs used. An efficient crop production is said to be that which has the lowest unit cost of production. It would, therefore be desirable to identify efficient crop zones based on high production in terms of efficient resource use and low cost of production. Uttar Pradesh which has been categorised as inefficient zone in the above classification, having a high spread but low yield index happens to be one of the efficient producers of sugarcane since the cost of production per quintal is lowest in the State. It is, therefore, evident that no single criterion could be used for 'efficiency' categorisation of crop zones.

6.13 The basic limitation of the above approach is that it overlooks the fact that limitation of resources like irrigation can give a picture of apparent inefficiency even when resource use is efficient. For example, in areas where a very small percentage of area is irrigated, high yields of certain irrigated crops may be associated with very low spread. Similarly, in the case of dry land agriculture, low yields of certain crops on account of low rainfall may be associated with high spread of such crops.

Recent Technological Developments

6.14 The evolution of new short duration and high yielding varieties has changed the scenario of crops production. These new varieties are mere adaptable to environment and can easily be adjusted in the cropping system as alternative/supplementary or catch crops. Wherever such better crop varieties have been evolved and are made available to the farmers, shifts in cropping patterns are in evidence. Introduction of winter maize in Bihar, short duration rainy season (kharif) pigeon pea (arhar) in Punjab, summer groundnut in irrigated areas of Gujarat, Andhra Pradesh, Orissa and Maharashtra and soyabean in Madhya Pradesh are a few examples. It is thus evident that crop production technology in terms of new/short duration varieties plays the most crucial role in effecting shifts in cropping pattern.

6.15 The impact of the technology evolution in seed material has, however, tended to get localised. It is essential that new and short duration varieties suited to a large variety of agro-climatic zones of the country are developed and multiplied to facilitate quicker transformation in cropping systems.

Possibilities of Raising Yields of Different Crops

6.16 Potential of the available technology for raising yield has been demonstrated in the results of National Demonstrations. However, it is usually not feasible to transfer all the available technology to the field. Farmers may also not be using the recommended package of practices fully in respect of transferred technology. The levels of yields actually attained would depend upon the extent to which available technology is transferred to the field and adopted by the farmers.

TABLE 6·1—*Average Yield of Crops in Natural Demonstration in Comparison to State Average under Irrigated Conditions*, (1983-84)

Range (Ratio)	State	Average yield Qtl./ha.		
		National Demons.	State	Ratio
(1)	(2)	(3)	(4)	(5)
PADDY				
1·00 to 1·99	Punjab	62·86	45·94	1·37
	Tamil Nadu	39·08	28·33	1·38
	Haryana	58·30	37·28	1·56
	West Bengal	38·51	22·17	1·74
	Karnataka	50·83	28·75	1·77
	Jammu and Kashmir	57·80	32·50	1·78
	Kerala	45·60	24·84	1·84
	Maharashtra	43·78	23·05	1·90
	Andhra Pradesh	61·48	31·67	1·94
2·00 to 2·99	National Average	48·27	21·83	2·2
	Uttar Pradesh	43·41	18·99	2·29
	Assam	37·44	16·31	2·30
	Rajasthan	48·33	20·37	2·37
	Orissa	42·65	17·81	2·39
	Bihar	40·21	15·20	2·65
	Himachal Pradesh	47·71	18·03	2·65
3·00 to 3·99	Madhya Pradesh	48·42	14·55	3·33
WHEAT				
1·00 to 1·99	West Bengal	26·25	25·96	1·01
	Punjab	40·67	30·15	1·35
	Haryana	36·37	24·99	1·45
	Assam	19·38	12·89	1·50
	Orissa	28·64	19·10	1·50
	Gujarat	38·00	21·95	1·78
	National Average	31·82	18·43	1·73
	Rajasthan	30·06	15·94	1·89
	Bihar	30·40	15·52	1·90
2·00 to 2·99	Uttar Pradesh	45·56	18·90	2·41
	Maharashtra	26·36	9·65	2·73
	Madhya Pradesh	34·01	11·57	2·94
3·00 to 3·99	Jammu & Kashmir	30·80	8·40	3·67
	Karnataka	24·60	6·24	3·94
4·00 & above	**Himachal Pradesh**	32·55	8·07	4·03
	Andhra Pradesh	33·75	7·14	4·73

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TABLE 6.1—*Contd.*

Range (Ratio)	State	Average yield Q.l./ha.		
		National Demons.	State	Ratio
(1)	(2)	(3)	(4)	(5)
MAIZE				
1·00 to 1·99	Karnataka	32·15	27·19	1·18
	Rajasthan	22·85	13·76	1·66
	Himachal Pradesh*	30·98	16·08	1·93
2·00 to 2·99	Uttar Pradesh	21·89	10·04	2·18
	Punjab	40·50	18·30	2·21
	National Average	30·86	13·52	2·28
3·00 to 3·99	Bihar	43·87	11·34	3·87
JOWAR				
1·00 to 3·99				
4·00 & above	Madhya Pradesh	38·77	9·32	4·16
	Maharashtra	30·77	7·15	4·30
	Karnataka	35·00	7·94	4·41
	National Average	34·71	7·25	4·79
BAJRA				
1·00 to 1·99	Tamil Nadu	15·90	11·75	1·35
2·00 to 2·99	Gujarat	25·36	11·19	2·27
	Uttar Pradesh	20·95	8·67	2·42
	Haryana	18·87	6·56	2·88
3·00 to 3·99	National Average	24·34	6·53	3·73
4·00 & above (Gram)	Rajasthan	22·00	4·91	4·48
	Karnataka	28·25	5·41	5·22
	Maharashtra	32·15	5·01	6·42
GROUNDNUT				
1·00 to 1·99	Orissa	16·78	15·45	1·09
	Uttar Pradesh	17·64	6·48	1·18
	Kerala*	11·50	8·83	1·30
	National Average	15·61	9·40	1·66
	Maharashtra	17·12	9·97	1·72
	Karnataka	14·68	8·41	1·74
	Punjab	12·62	7·24	1·74
2·00 to 2·99	Bihar	22·10	9·85	2·24
	Haryana	20·00	7·97	2·51
	Andhra Pradesh	26·30	10·3	2·55
MUSTARD				
1·00 to 1·99	Bihar	8·50	7·57	1·06
	West Bengal	8·49	5·97	1·42
	Gujarat	20·34	13·59	1·50
	Orissa	7·[illegible]	4·76	1·62
2·00 to 2·99	National Average	15·33	6·73	2·28
	Haryana	20·50	8·05	2·55
	Rajasthan	21·25	7·90	2·69
3·00 to 3·99	Uttar Pradesh	17·00	5·36	3·17
GRAM				
1·00 to 1·99	Bihar	9·60	8·81	1·09
	Karnataka	5·60	3·97	1·41
	Haryana	7·00	4·87	1·44
	National Average	11·83	6·63	1·78
	Madhya Pradesh	12·60	6·76	1·86
2·00 to 2·99			—NIL—	
3·00 to 3·99	Maharashtra	13·71	4·28	3·20
	Rajasthan	22·50	6·06	3·71

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*Relate to 1981-82.

CHAPTER VII

SOCIALLY OPTIMAL CROPPING PATTERN

7.1 A SOCIALLY desirable and appropriate cropping pattern should (i) try to bridge the gap between demand and supply and help attaining self-sufficiency in essential agricultural commodities like foodgrains, edible oils *etc.*, in the long run; (ii) lead to maximisation of farm incomes especially in small farm situations; and (iii) optimise resource allocations.

Demand for Major Agricultural Commodities

7.2 Estimating the economic demand for various commodities requires sound judgment on various issues, chiefly (i) identifying appropriate co-efficients of demand elasticity; (ii) determining parameters affecting demand *viz.*, rates of growth of per capita income/expenditure and population; (iii) choice of base period; and (iv) computing base level demand.

7.3 Based on the approach indicated above the all-India projections of demand for principal agricultural commodities need to be carefully worked out.

Supply Projections and Demand

7.4 Production of agricultural commodities in the past has shown certain growth pattern. It needs to be ascertained in the first instance that if these trends in production pattern continue in years to come, whether production will meet the demand of major commodities or else what modifications would be necessary in these trends. Based on the past trends/growth rates during the period 1967-68 to 1983-84, projections of production have been attempted upto 2000 AD. The projected production as well as the projected demand estimates have been shown in Table 7.1.

7.5 It is evident from the table that if past trends in crop and production pattern continue till the end of century, large imbalances are likely to develop between their supply and demand. Production of rice and wheat will reach 78.56 and 101.44 million tonnes as against projected demand of 90.00 and 74.00 million tonnes, respectively. Thus, whereas production of rice is likely to be short of demand after allowing for feed, seed and wastage, wheat production would turn out to be higher than effective demand. Production of pulses has been stagnating in the past and is likely to be significantly short (by 8 million tonnes) of the projected effective demand of about 21 million tonnes.

7.6 In case of oilseeds, which have shown a growth rate of production of 1.92 per cent per annum, production is likely to be around 170 lakh tonnes as against its effective demand of about 220 lakh tonnes. It shows that if existing trends in crop production are allowed to continue the Nation will have to continue to resort to large scale import of edible oils, *i.e.*, about three times the existing level.

7.7 In case of other major crops like cotton, jute, sugarcane *etc.*, there are only marginal differences between the likely production and projected effective demand.

7.8 Gaps between likely production and projected effective demand at the national level are associated with accentuation in regional imbalances. Production of most crops in the country is of a localised nature. Higher rates of growth in production of a crop in one region and lower in other leads to imbalances between supply-demand at the regional level and in returns to farmers across regions.

7.9 Most of the coarse cereals and pulses are cultivated in rainfed areas, and if production of these crops is not increased through raising productivity levels, differences between the incomes of farmers in the rainfed and irrigated areas are likely to increase. This would not be a socially desirable phenomenon.

Modified Production Pattern

7.10 In view of the likely future imbalances between production and demand, it would become essential to modify the production trends. Cropping pattern and production system in a region are generally quite stable and it is rather difficult to effect any sudden change. The Group is of the view that modification of production and cropping pattern is a slow process and desired shift in the cropping pattern can only be effected gradually over a long term perspective.

7.10A The modifications necessary in the present growth trends of agricultural commodities may be broadly visualised as follows :

(a) the rate of growth of production of rice has to be accelerated significantly to achieve the relatively higher level of desired production.

(b) Further expansion of area under wheat may have to be contained and emphasis should be to maintain the rate of growth of its productivity. If the existing rate of growth of productivity at 3 per cent per annum is maintained, it would be enough to attain the desired level of production. However, this would call for much greater development effort in the States of Uttar Pradesh, Bihar, Madhya Pradesh, Rajasthan and in some other States where large potential exists.

(c) Growth rate of production of coarse cereals has been very slow. However, a well established technology of hybrids of millets—jowar, bajra and maize is available, the diffusion of which has so far been restricted only to a few regions. States which have adopted hybrids of jowar and bajra like Maharashtra and Gujarat, have shown a significant step-up in the rate of growth of productivity of over 2.5 per cent per annum. Since coarse cereals account for about 30 per cent of the total area under foodgrains crops, it is essential to raise the productivity of this group of crops. Going by the past trend, it would not be possible to make major changes in area under these crops, but significant potential exists for raising productivity through adoption of technology of hybrids.

(d) A major constraints for adoption of hybrid varieties of millets was its very high susceptibility to pests and diseases. It is, therefore, suggested that plant protection facilities should be strengthened in areas where cultivation of millets is on a large scale.

(e) Production of pulses has remained static between 12-13 million tonnes during the last three decades though its demand during this period has increased significantly both because of rising population and per capita incomes. Its demand is likely to increase at a faster rate than that of cereals due to high income elasticity of demand. The increasing gap between rapidly rising demand and stagnant production has resulted in sharp increases in its prices. It is, therefore, necessary to strengthen and step up programmes of increasing production of pulses.

(f) The Group was informed by the ICAR that a good number of improved high yielding varieties of pulse crops like gram, tur and moong have been evolved which have a very good yield potential. Extensive efforts should be directed to popularise the use of these varieties to raise the productivity of pulses. Use of rhizobium culture has the potentiality to raise the yield of even the existing varieties to the extent of 20—30 per cent under existing management conditions. However, availability of rhizobium culture is the major constraint. It is, therefore, suggested that production of rhizobium culture should be taken up on a large scale wherever laboratory facilities are available in colleges and agricultural universities and its use popularised.

(g) The need for raising the production of oilseeds is well recognised. Programme for raising their production have been taken up under the National Oilseed Development Project under the aegis of the Technology Mission on Oilseeds Production. This Group would like to reiterate the need for strengthening these programmes and efforts to augment the desired production.

(h) The trends in production of major commercial crops *e.g.*, sugarcane, cotton, jute *etc.*, are fairly encouraging. The policy and programmes pursued in the past in regard to production, price and marketing support need to be continued in future to sustain the growth of these crops at the past level.

Limited Possibility of Expansion in Cropped Area

7.11 The net area sown in the country during the last six years has been almost steady at 143 million hectares. Any additional area to be brought under cultivation through reclamation of cultivable waste land would more or less offset the likely loss of cultivated land due to its transfer to non-agricultural uses. It is, therefore, quite likely that the net cultivated area in the country may not change significantly in the near future.

7.12 The only possibility of expansion of cropped area in the country is through the increase in area sown more than once. The area sown more than once has increased from about 32 million hectares in 1978-79 to about 37.5 million hectares in 1983-84. This became possible through expansion of net irrigated area from about 38 to 52 million hectares. Past experience shows that one per cent increase in gross irrigated area results in 0.3 per cent increase in gross cropped area. As per development perspective envisaged under the Seventh Plan and past trends in increase in irrigated area, it is felt that gross

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irrigated area will go up by 15 to 18 million hectares till the end of the century. Taking into consideration the existing level of gross irrigated area at 55 million hectares and elasticity of gross cropped area (0.3) as well as area sown more than once (0.8) with respect to irrigation it is felt that gross cropped area in the country is likely to increase by about 7 per cent or by 12 million hectares. This area increase will mainly come through increase in area sown more than once because of the availability of irrigation.

Allocation of Additional Area

7.13 Additional cropped area as a result of increases in area sown more than once with the expansion in irrigation facilities will get allocated amongst different crops. In this regard past experience shows that—

- (i) Bulk of the addition in cropped area due to increase in area sown more than once, with expansion in irrigation, is made in rabi crops. It is usually in rabi that fields are kept fallow under rainfed conditions in the absence of sufficient soil moisture.
- (ii) Amongst rabi crops, bulk of irrigated area went under wheat. Rapeseed & mustard, sugarcane, potato, summer paddy, summer groundnut and fruits & vegetables are other rabi crops which accounted for significant irrigated area.
- (iii) Extension of irrigated facilities to new areas has generally resulted in a shift in cropping pattern from millets and other low yielding crops to paddy and other high yielding crops during kharif season.
- (iv) Kharif oilseeds and pulses have so far been not much benefited from expansion in irrigated area.

7.14 It was felt that existing trend of allocation of irrigation facilities was not very conducive for balanced growth in agriculture. There is need to change the production technology of oilseeds and pulses to attract irrigated areas to these crops. This would also maximise social benefits by a more balanced use of water resources in the country. In order to develop a socially desirable cropping pattern, the Group considered future requirements of various commodities, forceable developments in technology, the need for rational allocation of water to crops, particularly to oilseeds, pulses *etc.* This would involve consideration of various policy issues including rationalisation of water rates, pricing, incentives/disincentives *etc.*, as discussed in various sections of this Report.

All-India Optimal Cropping Pattern

7.15 Taking into consideration different issues, as discussed earlier, the Group has attempted to present a socially desirable optimal cropping pattern at the all-India level in Table 7.2. The projected cropping pattern shows that—

- (i) Out of additional cropped area of about 12.0 million hectares which is likely to develop, about 4.7 million hectares each might be allocated to rice and wheat crops. It would slightly increase the rate of growth of area under rice whereas in case of wheat it would imply deceleration in the existing rate of growth of area.
- (ii) With the expansion of irrigation facilities, some shift in area away from coarse cereals would be inevitable.
- (iii) It could be assumed that past trends of growth rates in area under gram and groundnut could be reversed as a result of programmes and policies undertaken for these crops.
- (iv) The overall growth rates of area under oilseeds and pulses has been projected to be about 1.5 per cent per annum each which would be quite significant. This would lead to an incresed proportion of area under these crops to total cropped area.
- (v) Quite a significant part of additional area to be brought under pulses and oilseeds would receive irrigation facilities. The overall proportion of irrigated area under these crops would, therefore, increase.
- (vi) No significant changes in growth rates have been assumed for other crops.

State-wise Allocation of Area under Principal Crops

7.16 Projections of cropping pattern for different States/Regions is a complex problem. Development of optimal cropping pattern for each region/State itself would require detailed information about soil and other geographical characteristics besides socio-economic determinants. This Group has, therefore, suggested only some broad directions in which the cropping pattern in different States need to be changed. While suggesting these changes for different States, the Group has taken into consideration—

- (i) past trends in cropping pattern;
- (ii) agro-climatic suitability;

(iii) likely expansion in irrigation facilities;

(iv) relative yield and profitability of competing crops; and

(v) existing level of diffusion of technology and future expectation of its transfer.

7.17 Major observations on desired changes in cropping pattern for major crops/States are offered below :

(a) Area under rice is expected to increase with expansion of irrigation facilities particularly in the States of Andhra Pradesh, Assam, Bihar, Haryana, Madhya Pradesh, Punjab, Uttar Pradesh and West Bengal. In the Southern States of Kerala, Karnataka and Tamil Nadu, where growth rates of area under rice were negative in recent years, further decline may need to be checked.

(b) Coverage of area under rainfed paddy in the six Eastern States covered under Special Rice Production Programme is likely to increase. Some increase in area under paddy is also anticipated in other major producing States.

(c) Wheat is the only crop which has shown significantly positive growth of area in all the States so far. Since the rate of growth of its productivity was about 3 per cent per annum, its rate of growth of area was projected to be about half of the existing rate of growth of 2.58 per cent per annum observed between 1967-68 to 1984-85. This would require certain checks on shift in irrigated area to wheat crops in major wheat growing States of Punjab, Haryana and Uttar Pradesh.

(d) Area under gram is projected to increase in Madhya Pradesh, Uttar Pradesh, Rajasthan and Haryana. The earlier declining trend in growth of area in Haryana and Uttar Pradesh needs to be reversed with appropriate price and water rates policies.

(e) Area under tur has shown positive growth rate in certain States which needs to be maintained. Its area needs to be expanded particularly in Uttar Pradesh where it has been declining of late. Reduction in area under tur in Uttar Pradesh was observed because of reduction in area under jowar and bajra with which tur was cultivated as mixed crop. To expand area under tur, it is necessary to propagate pure cultivation of short duration varieties of the crop.

(f) Area under other pulses also has to be increased not only in States where it has already shown positive growth rates but also in the Northern States of Haryana, Rajasthan and Uttar Pradesh where past trends were negative.

(g) Area under kharif groundnut needs to be improved significantly. Past growth rates have been either nominal or negative in almost all the major growing States except Gujarat and Orissa. Presently, groundnut cultivation is being carried out under poor input management conditions. Profitability analysis of groundnut with competing crops has shown that with some improvements in its productivity this crop can have an edge over jowar, bajra, ragi, cotton or even paddy in certain areas. With certain promotional programmes being introduced under the Technology Mission on Oilseeds Production. Area under groundnut is expected to increase in Gujarat, Karnataka and Tamil Nadu. Some increase in area is also expected in some minor producing States.

(h) Growth of area under rapeseed & mustard has been quite impressive in all the major growing States except Uttar Pradesh and Punjab. Economics of its production shows that it has an edge in profitability over other competing crops including wheat in the States of Haryana, Rajasthan, Uttar Pradesh and marginally also in Punjab. This crop is expected to improve its share of area in these States particularly when further shift in area in favour of wheat is to be restricted.

(i) No major change in area under sugarcane is envisaged as this crop continues to be quite remunerative as compared to alternative crop rotations as a whole under existing yield and price structure. However, further expansion of its area may need to be restricted particularly in Maharashtra and Gujarat where water resources are scarce and social returns to water application in other crops are much higher. The major emphasis for increasing sugarcane production should be through increase in yield per hectare. Large potential for increasing yield per hectare of sugarcane exists in the sub-tropical zone covering the States of Uttar Pradesh, Bihar, Haryana and Punjab.

(j) In the case of cotton, jute *etc.*, no major shifts in crop acreage trends are being suggested as trend growth rates of production and productivity of these crops were quite encouraging.

TABLE 7·1 :—*Trend Production and Projected Demand of Major Agricultural Commodities*

Commodity	Compound rate of growth 1967-68 to 1984-85	1984-85 (Revised) estimates	Projection in Million Tonnes 1989-90	1994-95	1999-2000	Projected Demand in 1999-2000
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Rice	2·37	58·34	62·15	69·88	78·56	90·00
Wheat	5·70	44·07	58·27	76·88	101·44	74·00
Coarse Cereals . .	0·93	31·17	32·41	33·94	35·55	36·00
TOTAL PULSES . .	0·51	11·96	12·63	12·96	13·29	21·00
TOTAL FOODGRAINS . .	2·68	145·54	162·88 (165·46)	185·91 (192·66)	212·19 (228·84)	221·00
Oilseeds	2·43*	12·95	13·45	15·17	17·10	220
Sugarcane	2·11	170·32	206·36	237·84	274·12	300
Cotton £ . . .	2·19	8·51	8·29	9·29	10·35	320
Jute & Mesta @ . .	2·02	7·79	7·26	8·05	8·93	130

*Growth rate for nine oilseeds (actual) is taken for the period 1970-71 to 1984-85.

£Production is in Million bales of 170 kg. each.

@Production is in Million bales of 180 kg. each.

NOTE— Figures given in brackets for total Foodgrains are such of the individual projections of Rice, Wheat, Coarse Cereals and Total Pulses.

TABLE 7·2—*All-India Projected Optimal Cropping Pattern*

(Million hectares)

Crop	Triennium ending 1984-85 Area	Per cent to total	1989-90 Area	Per cent to total	1994-95 Area	Per cent to total	1999-2000 Area	Per cent to total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Rice	41·10	22·77	42·40	23·02	44·20	23·51	45·80	23·88
Wheat	23·76	13·16	25·60	13·90	27·60	14·68	29·46	15·36
Jowar	15·88	8·80	15·70	8·52	14·60	7·77	14·00	7·30
Bajra	11·04	6·12	10·90	5·92	10·60	5·64	10·30	5·37
Maize	5·84	3·23	5·60	3·04	5·30	2·82	5·10	2·66
Ragi	2·50	1·39	2·62	1·42	2·70	1·44	2·80	1·46
Small Millets . .	3·50	1·94	3·27	1·77	3·00	1·60	2·73	1·42
Barley	1·30	0·72	1·20	0·65	0·90	0·48	0·80	0·42
Gram	7·24	4·01	7·50	4·07	7·90	4·20	8·40	4·38
Tur	3·20	1·77	3·55	1·93	3·87	2·06	4·20	2·19
Other Pulses . . .	13·00	7·20	13·80	7·49	15·00	7·98	17·00	8·86
Groundnut . . .	7·34	4·08	7·70	4·18	8·30	4·42	8·95	4·67
Rapeseed & Mustard .	3·90	2·16	4·20	2·28	5·10	2·71	6·20	3·23
Other Oilseeds . .	7·59	4·20	8·00	4·34	8·83	4·70	9·75	5·08
Sugarcane . . .	2·97	1·64	3·20	1·74	3·45	1·84	3·60	1·88
Cotton	7·56	4·19	7·75	4·21	7·95	4·23	8·15	4·25
Jute	0·83	0·46	0·84	0·46	0·87	0·46	0·92	0·48
Mesta	0·30	0·17	0·31	0·17	0·33	0·18	0·36	0·19
Potato	0·83	0·46	0·90	0·49	1·00	0·53	1·12	0·58
Tobacco	0·52	0·21	0·58	0·31	0·66	0·35	0·74	0·39
Others	20·30	11·24	18·60	10·09	15·82	8·40	11·40	5·95
TOTAL CROPPED AREA .	180·50	100·00	184·22	100·00	187·98	100·00	191·78	100·00

CHAPTER VIII

SUMMARY OF FINDINGS AND RECOMMENDATIONS

A SUMMARY of our findings and recommendations are given below on a Chapter-wise basis :

Chapter II : Existing Cropping Pattern & Trends in Area Expansion

1. During the first decade of planning *i.e.*, from 1950-51 to 1960-61, there was not much change in the cropping pattern in spite of significant increase of about 22 million hectares in cropped area. The proportion of area under rice and wheat together remained around 30 per cent of total cropped area. There was marginal increase in proportion of area under sugarcane, groundnut, cotton and pulses during this period. (para 2.3)

2. The introduction of dwarf/high yielding varieties of rice and wheat and hybrids/composites of millets in mid sixties led to a shift in area towards crops in which the impact of technology on yield was apparent. The proportion of area under wheat has shown a continuous increase over time while that under coarse cereals recorded a declining tendency. There has not been any significant change in the proportion of area under rice to total cropped area during the entire period of planned development. Amongst non-foodgrain crops, the share of area under sugarcane, rapeseed & mustard and potato in the total cropped area recorded significant increases while that under groundnut, cotton and jute has been fluctuating. (paras 2.4, 2.5)

3. Growth rates of area under principal crops during post-green revolution period (1967-68 to 1984-85) were quite uneven resulting in marked changes in cropping pattern. Wheat witnessed the highest rate of growth of area (2.58 per cent per annum) as against the overall per annum growth rate of area at 0.46 per cent. Growth rate of area under rice was marginally higher than growth rate of area under all crops. Gram and coarse cereals like jowar, bajra, maize, small millets and barley have shown negative growth rate of area during this period. Groundnut showed very low rate of growth of area (0.12 per cent per annum) as against as high growth rate as 4.01 per cent during the earlier period (1949-50 to 1964-65). The overall rate of growth of area under oilseeds during the period-II was only one-fifth of that observed during the period 1949-50 to 1964-65 (paras 2.9—2.11)

4. During the post-green revolution period shifts in cropped area within foodgrain crops is quite marked. During kharif season shift has taken place from millets to rice whereas during rabi, barley and gram with negative growth rates in rea seem to have been re placed by wheat. (para 2.13)

5. Expansion in irrigation facilities has played an important role in causing a shift in cropping pattern. Over 70 per cent of the additional irrigated area of about 26 million hectares developed between 1960-61 to 1983-84 was accounted for by wheat and paddy. Wheat alone accounted for about 53 per cent of the additional irrigated area. Cash crops which have been benefited from additional irrigated area included sugarcane, groundnut, rapeseed & mustard, cotton and fruits and vegetables. (para 2.14)

6. The rate of growth of total cropped area was marginal (0.15 per cent per annum) during the period 1980-81 to 1985-86 as against 0.54 to 0.68 per cent per annum during the period 1960-61 to 1979-80 and 1.64 per cent during the period 1950-51 to 1959-60. Because of very slow growth rate of total gross cropped area, crops which have shown high rates of growth of area have done so at the cost of crops with low or negative growth rates. (para 2.16)

7. Rice, wheat, tur and other pulses, except gram, amongst foodgrains showed a relatively higher rate of growth in area while jowar, maize, bajra and gram showed a declining trend. In case of kharif oilseeds crops, groundnut, sesamum, linseed and niger seed there was a decline in area whereas there was an increase in area in case of rabi groundnut, rape & mustard, castor seed and newly introduced crops like safflower, sunflower and soyabean. A significant growth in area was observed in case of cotton, jute & mesta though sugarcane has not shown any significant increasing trend in area. (para 2.17)

8. Because of these trends in area, as well as differential rates of growth in yield per hectare, growth rate of production was positive and significant in case of rice, wheat, total pulses, oilseeds, cotton and mute. Growth rates of production of total pulses and oilseeds were 3.46 and 3.83 per cent per annum during 1980-81 to 1985-86 as against 1.49 and 1.39 per cent per annum, respectively during the period 1970-71

to 1978-79. Sugarcane production in recent years (1980-81 to 1985-86) has shown relatively lower growth rate (0.52 per cent) as against 4.19 per cent per annum during the period 1970-71 to 1978-79. (para 2.18)

9. Expansion in area has occurred in favour of those crops which have either shown a higher growth rate of productivity due to technological development or whose relative prices with competing crops have moved in their favour or high growth rates in yields were combined with high prices resulting in sharp increases in their total productivity. The farmers' decision on area allocation between crops was thus founded on sound economic criteria. (para 2.23)

10. Here increase in the price of an agricultural commodity has a limited impact on expansion of acreage under it, as is illustrated by pulses and oilseeds whose support prices have been increased more than proportionately compared to major cereals, while growth rates of area under and production of these crops remained much lower. (para 2.25)

11. Another important feature in the economy of pulses and oilseeds is the relatively more pronounced order of seasonal fluctuations in their prices because adequate marketing support has been somewhat lacking. (para 2.26)

It is imperative that besides the development of technology, effort should be made to stabilise the prices of pulses and oilseeds to check sharp inter-season variations. This calls for adequate market support besides reasonably remunerative guaranteed price. (para 2.27)

12. Farmers are generally quite rational in their choice regarding combination of crop enterprises, in the context of their access to resources and capacity to invest. They have achieved very high levels of efficiency in combining resources and crop enterprises under given technological possibilities and factor product price relationship. (para 2.28)

Chapter III : Economics of Crop Enterprises

13. *Rice* : Since low yielding states account for about 20 million ha. (half of the total area under the crop), increase in the yield levels could result in additional production of about 8–10 million tonnes. Besides there will be normal increase in yields in other ricee growing States. Additional production of rice of about 12–15 million tonnes could be achieved by improving the efficiency of use of inputs without expanding area under this crop. The desired expansion of area under rice could be effected in States which are more efficient producers. (paras 3.8 & 3.9)

14. *Wheat* : By improving the use efficiency of existing irrigation water through better management and increased and balanced fertiliser application there is scope for increasing the yield of wheat by about 50 to 70 per cent in Madhya Pradesh and Rajasthan and about 25 to 30 per cent in Uttar Pradesh and Bihar with the existing technology. This order of increase in productivity would result in increased wheat production by about 30 per cent. Besides there is scope for expansion of area under the crop in non-traditional growing States like Maharashtra and West Bengal. (paras 3.12 & 3.13)

15. *Jowar* : Going by trends and relative productivity of this crop it is felt that it may not be possible to expand its area to any significant level in the near future. However, there seems to be significant scope for increasing its production through raising yield per ha., by extending the coverage under hybrid varieties and increased use of fertilisers; particularly in areas which have relatively assured rainfall. The average productivity can be increased by over 30 per cent by transfer of available technology through appropriate extension efforts. (para 3.15)

16. *Bajra* : Because of new technology available there is a significant potential for increasing the productivity of this crop. It is felt that productivity can be increased by about 50 per cent with this technology. This would call for greater extension effort particularly in Haryana, Rajasthan, Uttar Pradesh and Maharashtra. (para 3.19)

17. *Maize* : The yield of this crop, on an average, can be increased by about 300 Kg. if average fertiliser consumption could be raised to about 35—45 Kg. per ha. It may be possible to achieve this level in the next 5—8 years, by adoption of hybrid varieties. (para 3.21)

18. *Groundnut* : The largest producer of the crop is Gujarat which has almost the lowest yield per ha. even though the level of fertiliser application is highest in the State. This aspect needs to be examined further. (para 3.23)

19. In view of the potential for high productivity of groundnut in Orissa, this crop has considerable prospect in the State. Past trends in expansion of area support this and also suggest that Orissa may

become one of the leading producers of groundnut in the next decade.

(para 3.24)

20. *Rapeseed and Mustard* : The existing level of profitability of this crop suggests that it has an edge over competing crops. However, even though the output-input ratio is high, this crop has low yield and is cultivated with low fertiliser application. Extension efforts need to be directed towards motivating farmers to increase the application of fertilisers and other package of practices, particularly in irrigated areas. This would help raise productivity and improve overall profitability.

(paras 3.26 and 3.27)

21. *Gram* : This is being cultivated under very poor management conditions, by and large in rainfed areas and the application of fertilisers was exceptionally low. Application of 25–30 Kg. of phosphatic fertilisers per hectare would result in substantial increase in yield. It would, therefore, be desirable that extension efforts should be directed to popularise the use of phosphatic fertilisers to improve productivity. Gujarat has very good potential for expansion of area under this crop.

(paras 3.30 and 3.31)

22. *Tur (Arhar)* : Like gram, this crop is also cultivated under poor management conditions, irrigated area under the crop being negligible and fertiliser application very low. There is significant scope for improving the productivity of this crop through better management and increased use of fertilisers, particularly in Karnataka, Madhya Pradesh, Tamil Nadu and Andhra Pradesh where currently yields are very low.

(para 3.34)

23. *Cotton* : Cost of production per unit of output is very high in major producing States like Maharashtra, Gujarat and Punjab. Madhya Pradesh and Maharashtra have very low productivity levels due to fertiliser consumption being low. These States have favourable output-input ratio which indicates that there is scope for increasing fertiliser consumption as well as productivity in these States.

(para 3.36)

24. *Jute* : There is scope for increasing productivity in Bihar and Assam through increased application of fertilisers.

(para 3.39)

25. *Oilseeds and Pulses*

(a) Under the existing level of technology, yield and price-cost structure, it appears unlikely that groundnut will replace paddy to any significant extent in most of the States. (para 3.41)

(b) Value of output per hectare of rapeseed & mustard was comparable with that of wheat. Profitability over paid-out costs as well as total costs was much higher in case of rapeseed & mustard compared to wheat and gram in Haryana, Rajasthan and Madhya Pradesh. This crop can replace wheat, at the margin, in these States. (para 3.42)

(c) Gram is more profitable under existing yield levels in Haryana and Rajasthan. It's profit margin was higher than wheat in U.P. There was, therefore, scope for shifting area to this crop in certain regions of these States. (para 3.43)

(d) The returns from soyabean were much higher than from jowar in Madhya Pradesh and paddy in U.P. With proper price support measures soyabean could easily be substituted for jowar and paddy in Madhya Pradesh and U.P. respectively.

(para 3.44)

26. *Substitution of Sugarcane* : Sugarcane is a long-duration crop spread over almost a whole year in the sub-tropical region and a crop rotation of competing crops needs to be studied for judging comparative economics. The net income from the substitute set of crops has been found to be lower than for sugarcane in sub-tropical region. This suggests that even in the low yielding States of Bihar and U.P., sugarcane production is profitable in relation to its competing crops. (paras 3.45 and 3.46)

Chapter IV : Irrigation and Cropping Patterns

27. In six of the eleven projects studied by us (ORG), 44 to 91 per cent of the gross irrigated area was under kharif rice. Wheat was the next important crop accounting for more than 25 per cent of the gross irrigated area in five projects. Paddy and wheat together accounted for between 60 and 95 per cent of the gross irrigated area in 8 projects. The factors which may be responsible for lack of crop diversification included small land holdings which prompted farmers to grow staple food and risk-free crops, absence of HYVs, particularly of pulses and oilseeds and a general reluctance to or a very slow process of adoption of new crops by the farmers. Organised market support and supply systems for necessary inputs could also not develop because of this.

(paras 4.15 and 4.16)

28. Factors responsible for cropping patterns in surface irrigation systems being different from what were planned include—(i) plentiful water availability in upper reaches in initial years which encouraged paddy, (ii) water logging close to canals and branches in upper reaches, (iii) inability of irrigation authorities to deliver water according to crop requirements in projected pattern, (iv) prolonged kharif season due to dependence of sowing on first substantial rains, and (v) pre-emptive action on the part of farmers in the upper reaches by starting a second crop, often paddy, at the end of their early kharif crop or cultivating perennial crops like sugarcane. (para 4.17)

29. Inefficient water management in irrigation commands led to problems like water-logging and soil salinity and also the emergence of cropping patterns different from the ones envisaged. (para 4.18)

30. The phenomenon of crop diversification as envisaged in original project formulations has not been achieved in most of the projects studied. Even crops which are efficient from the point of view of returns per unit of water like maize, gram, pulses, vegetables, groundnut, sesamum and soyabean have not come up well in irrigated areas. (para 4.30)

31. It is desirable to promote larger acreage under these crops (*i.e.* maize, *etc.* referred to in the previous recommendation). Promotion of different crops in various irrigation commands should be based on considerations of high return per unit of water and national priority for raising production of oilseeds, pulses etc. (para 4.32)

32. Projects which have limited canal water availability should give high priority to promotion of kharif-rabi combinations with gram or wheat or oilseed. This will provide additional return to farmers and also lead to more efficient water use. (para 4.34)

33. Greater efforts are needed to increase the production of oilseeds and pulses both through expansion of irrigated area under them and raising productivity. Crops like mustard, soyabean and safflower should receive special attention. (para 4.35)

34. It would be difficult to replace paddy in most of the project areas. However, desired changes and shift in cropping patterns even in paddy dominated areas could be effected by appropriate policies and programmes. Promotion of short duration paddy and also short duration pulses like urad and moong would help in improving dropping pattern and water utilisation. (Para 4.36)

35. Promotion of vegetables should be encouraged in irrigation projects with limited canal water availability. (para 4.37)

36. For promoting certain crops incentives like price support, input subsidies, market facilities, etc. may be effective. Suitable disincentives also need to be developed for discouraging water intensive crops which do not give adequate return per unit of water. (para 4.40)

37. A national policy to identify areas/projects where paddy is predominantly suitable should be formulated. Measures for discouraging paddy in areas lying outside the identified areas should be examined. (para 4.40)

38. A number of crop mixtures with oilseeds are available. Suitable crop mixtures of oilseeds with cotton, wheat *etc.*, should be identified for different regions/projects and propagated. (para 4.40)

39. Good technology in terms of quality seed, inputs, cultivation practices, *etc.* available in the LAB for oilseeds and pulses should be disseminated to the field expeditiously. (para 4.40)

40. Producers of oilseeds and pulses are generally small and marginal farmers. Marketing support in various forms should be provided. The role and operations of NAFED for this purpose should be expanded. (para 4.40)

41. *Irrigation Water Management*

(a) Irrigation water management is essential for the development of desired cropping pattern in the command areas. Water management is an important input for the development of high value crops in the command areas in both head and tail reaches. It is also a pre-requisite for improving crop productivity with reference to water utilisation. More importantly improved water management is necessary for ensuring quality and reliability in irrigation delivery system. (para 4.42)

(b) Water management practices in irrigation commands during kharif for—(i) low rainfall and (ii) high rainfall areas would be different. Some aspects of irrigation water management with the larger objective of improving the overall irrigation delivery system, which is expected to influence both directly and indirectly, the future cropping pattern are discussed below :

42. *High Rainfall Areas* : This is the area of large flows into the source of surface water for irrigation. This volume is either wasted by running canals when water is not needed (also in many cases causing degra-

dation of land quality) or water that can be diverted from the river goes unutilised. Even in storage projects water not used in the middle of the season may be lost by overflow at the reservoir later in the season. The usual farmer response in this situation is to irrigate only paddy and not adopt high yielding technology, in apprehensions of irrigation not being received as required (usually in excess, but often not available when needed). Under this situation for proper irrigation water management, the following are recommended :

(i) delineate special commands of homogenous rainfall, and establish cross regulators and other controls on main canals and major branches so that water can be supplied to any special command where rainfall is deficit.

(ii) so work out canal system operation procedures that appropriate response is made to any developing pattern of rainfall deficit. It would be proper to develop an early warning system for drought situation so that the canal system is activated early enough to be able to carry water to the farthest reaches before the drought becomes severe.

(iii) develop methods (perhaps computer based) to monitoring and anticipate rainfall deficit in the special commands.

(iv) make on/off operations feasible in a system where field to field irrigation is practised, the chaks have to be reorganised so that the number of fields in a series is limited.

(v) in case of storage projects, the benefits that could be obtained by carrying water in the reservoir over the dry season should be examined in depth so that assured irrigation can be provided for raising nurseries and for transplantation. (paras 4.44 & 4.45)

43. *Low Rainfall Areas* : Low rainfall areas are usually characterised by unreliable irrigation supplies in kharif under the concept of 'protective irrigation', which results in low rate of return per unit of water. In these project areas, farmers do not adopt high technology even for irrigated dry crops. Where rice is grown in upper parts of command, lower areas get little effective irrigation. In order to use irrigation water management as a tool for influencing cropping pattern, it is recommended that the number of irrigation turns that will be adequate to provide good irrigation to irrigated dry (ID) crops in most years should be worked out. An operational plan should be developed which takes into consideration a range of opening dates for each of the turns, with a well formulated procedure for determining the opening date for a turn on the basis of rainfall observed. The emphasis should be on anticipating occurrences of deficit conditions and pre-empting such occurrences at the expense of some wastage of water. Rice cultivation should be restricted to low slope areas at the bottom of distributories and other laterals, with high ground water availability, fed by irrigation which makes it economical to pump ground water to supplement surface deliveries. (para 4.46)

44. *Rabi Irrigation* : In case of rabi season, the practices considered for irrigation water management for both high and low rainfall areas are generally common. They are briefly enumerated hereunder :

(i). Irrigation in rabi should lay heavy emphasis on providing a high degree of assurance of supply to the farmer, in terms of quantum as well as distribution of deliveries during the season. In this regard it is recommended that

(a) methods to assess, to a high degree of reliability, the surface water that will be available must be developed. Where sources are shared by two or more States, clear delineation of shares has to be made and discipline in observing the agreed plan for use of common resources, especially by the upstream States enforced.

(b) Where power generation is associated with the project, coordinated planning of operation for irrigation and power must be done. This requires considerable efforts at improving operational planning in both power and irrigation sectors.

(ii) The method of deriving priorities, in practice in Punjab, Haryana, parts of Uttar Pradesh and Rajasthan and introduction of delivery irrigation in the face of uncertainty in water availability and poor communication is commended. Its greatest merit is that it gives a fair measure of equitability. However, there is still scope for improvement in the system. One of the approaches could be to give assured supply according to set schedule for tail-end areas and those needing a special treatment. For the rest of the command, making deliveries as close as possible to set schedules should be ensured. Such schedules should recognise variations in cropping patterns within the command. (para 4.47)

45. A study of prevailing irrigation rates indicates that there was no relationship between the irrigation

rates of different crops and related water requirements. If the rates could be linked with volumetric requirement of water for different crops this could be made more rational. Farmers would be then more cautious in their choice of crops and would go in for crops which have higher return to water. (para 4.51)

45. Low irrigation rates in relation to light duty crops, particularly oilseeds and pulses, may induce the farmers to go in for such crops under irrigated conditions. (para 4.51)

45A. Irrigation rates should not be so low as to induce over-use of water resulting in problems of drainage and land degradation. These should be at least able to recover the operational cost of the irrigation system. (para 4.53)

45B. Generally the rates of power for irrigation were based on H.P. of the engine. A more rational approach would be to link the power rates with actual use of water and not the H.P. of the engine. (paras 4.55 and 4.56)

Chapter V : Price Policy and Cropping Pattern

46. A selective use of price policy through minimum support/procurement prices has every chance of bringing about the desired shift in cropping pattern. (para 5.7)

47. It is essential that while considering price policy, the relationship between the productivity ratios of competing crops and their inverse price ratios is taken into account. (para 5.9)

48. If it is desired to increase production of commodities which experience considerable price uncertainty, more effective price and marketing support for such crops will have to be provided in relation to other crops. (para 5.10)

49. Maintenance of a certain element of stability in prices is necessary to protect vulnerable sections of the population from profiteering. (para 5.11)

50. If certain changes in cropping pattern are desired to be effected through pricing policy, parity in income from different crops needs to be considered. (para 5.12)

51. Prices, by themselves, have a limited role in increasing agricultural production and effecting a shift in cropping pattern unless these are supported by technological development. (para 5.14)

52. Agricultural price policy must not be considered in isolation for bringing about changes in cropping pattern but must be viewed in relation to supplementary changes in technology and crop husbandry. Besides, gains from international trade have also to be taken into account while fixing the prices of competing crops. (para 5.14)

53. An effective price policy should not only reduce uncertainty arising from seasonal fluctuations but also minimise the price spread. (para 5.15)

54. Market support operations should be taken up for commodities in which the producers' share in consumers' price is low on a regular basis. A proposal for buffer stock operations in edible oilseeds/oils needs to be considered in this context. (para 5.17)

55. In order to attain the desired cropping pattern it may be necessary to provide a more favourable price climate for crops for which no technological breakthrough has taken place. (para 5.18)

Chapter VI : Technology and Cropping Pattern

56. There is considerable scope for increasing yield of different crops although potential differs from State to State. Modernisation of agriculture through transfer of technology has to be accomplished taking into consideration targets set for agricultural production in a long or medium term perspective. (para 6.5)

57. In case of paddy. average yield can be increased from 1.25 to 3.5 times in different States and average productivity by about 50 per cent even if 75 per cent of the available technology can be transferred to the fields. In case of wheat, yield can be increased from 1.25 to 4 times. On an average at the national level the ratios between national demonstration yields and crop estimation yields for paddy, wheat, jowar, bajra and maize for 1983-84 were 2.21, 1.73, 4.79, 3.73 and 2.28 respectively. Yields of different crops can be raised to the potential levels provided available technology is transferred to farms through effective extension service supported by adequate and timely supply of inputs and necessary infrastructure. (paras 6.4—6.6)

58. There are considerable shortfalls in the actual levels of major inputs applied as compared to the recommended levels. Yield levels of different crops can be raised considerably if use of these inputs is stepped up. (para 6.7)

59. ICAR has identified efficient crop zones in recent studies for some principal crops, based on existing technology. On the basis of relative yield index and the relative spread index, areas under various crops have been divided under four categories viz.—(a) high spread, high productivity, (b) low spread, high productivity, (c) high spread, low

productivity, and (d) low spread, low productivity zones. Such a categorisation might have some general validity but might not serve as a sound criterion for grouping on the basis of efficiency, the basic limitation being that this approach overlooks the fact that limitation of resources like irrigation can give a picture of apparent inefficiency even when resource use is efficient. (paras 6.11—6.13)

60. The new technology (e.g. short duration high yielding varieties) has tended to get localised. It is essential that new and short duration varieties suited to a large variety of agro-climatic zones of the country are developed and multiplied to facilitate a quicker transformation in cropping systems. (paras 6.14 & 6.15)

Chapter VII : Socially Optimal Cropping Pattern

61. Projected production based on past trends and demand estimates upto 2000 AD are presented in Table 7.1. (para 7.4)

62. If past trends in crop area and production pattern continue till the end of century, large imbalances are likely to develop between their supply and demand. Whereas production of rice is likely to be short of demand, wheat production would turn out to be higher than effective demand. Production of pulses is likely to be significantly short of the projected effective demand. (para 7.5)

63. In case of oilseeds, production is likely to be 175 lakh tonnes as against an effective demand of 300 lakh tonnes. If existing trends in crop production are allowed to continue we will have to resort to large scale import of edible oils, about three times the existing level. (para 7.6)

64. Coarse cereals and pulses are generally cultivated in rainfed areas. If production of these crops is not increased, through raising productivity, difference between the incomes of farmers in rainfed and irrigated areas is likely to be increased. (para 7.9)

65. In view of the likely future imbalances between production and demand it would become essential to modify the present production trends. Such modifications would be slow process and can be effected gradually over a long term perspective. (para 7.10)

66. Modifications necessary in the present growth trend would particularly be :

(a) Rate of growth of production of rice to be accelerated significantly.

(b) Further expansion of area under wheat to be contained with emphasis on maintaining the rate of growth of its productivity.

(c) The existing potential for raising productivity to be tapped through the adoption of technology of hybrids in case of coarse cereals—jowar, bajra and maize.

(d) Strengthening of plant protection facilities for millets which are highly susceptible to pests and diseases.

(e) Strengthening and stepping up programmes of increasing production of pulses. Extensive efforts should be directed to popularise use of newly evolved varieties of gram, tur and moong and raise productivity through rhizobium culture.

(f) Programmes of development of oilseeds to be strengthened—as per NODP/TMO formulations. (para 7.11)

67. Gross irrigated area is likely to go up by 15 to 18 million ha. till the end of the century. Gross cropped area is likely to increase by 12 million ha. (para 7.12)

68. There is need to change the production technology on oilseeds and pulses to attract irrigated areas to these crops. To make this feasible it will be necessary to reorient suitably policies relating to water rates, pricing etc. (para 7.14)

69. Projected cropping pattern for 2000 AD is presented in Table 7.2. (para 7.15)

70. The broad features of the projected pattern are brought out in paras I to VI of para 7.15. (para 7.15)

71. Our major observations on desired changes in cropping pattern are as follows :

(a) Area under rice is expected to increase with expansion of irrigation facilities in Andhra Pradesh, Assam, Bihar, Haryana, Madhya Pradesh, Punjab, Uttar Pradesh and West Bengal. In Kerala, Karnataka and Tamilnadu, where area under rice is declining, further decline needs to be checked.

(b) Increase in area under rice is anticipated in six eastern States as also in some other major producing States.

(c) The projected rate of growth of area under wheat is about half the existing rate of about 2.58 per cent. Checks will have to be exercised on increase in irrigated area under the crop in Punjab, Haryana and Uttar Pradesh.

(d) Area under gram is projected to increase in Madhya Pradesh, Uttar Pradesh, Rajasthan and Haryana. The present decline in growth of area in Haryana and Uttar Pradesh needs to be reversed with appropriate price and water rate policies.

(e) The area under Tur needs to be extended in Uttar Pradesh where it is declining of late. It is necessary to propagate pure cultivation of short duration varieties.

(f) Area under pulses needs to be increased particularly in Haryana, Rajasthan and Uttar Pradesh where past trends were negative.

(g) Area under kharif groundnut needs to be increased significantly in Gujarat, Karnataka and Tamil Nadu.

(h) Area under rapeseed & mustard is expected to go up in Haryana, Rajasthan, Uttar Pradesh and also marginally in Punjab.

(i) No major change in area under sugarcane is envisaged. Further extension of its area needs to be restricted particularly in Maharashtra and Gujarat where water resources are scarce and social returns from alternative use of water higher. Large potential for increasing yield per hectare exists in the sub-tropical zone covering Uttar Pradesh, Bihar, Haryana and Punjab.

(j) The present trends in production and productivity of cotton, jute, etc. are encouraging and no major shifts are, therefore, suggested. (para 7.17)

APPENDIX--I

NOTE ON DETERMINATION OF SOCIALLY OPTIMAL CROPPING PATTERN

1. Preamble

1.1 THE imbalances between demand and supply of certain major agricultural commodities like pulses, oilseeds, cereals, sugar *etc.*, during recent years has caused considerable concern to the Government about allocation of area under different crops. While production of wheat has witnessed impressive growth through increases both in productivity and expansion of area, production of pulses has remained stagnant. In fact, area under pulses has been shrinking. Although production of oilseeds has shown some increase, its supply is still short of demand. Sharp fluctuations in production, resulting in imbalances between supply and demand, have at times affected nation's economy adversely. The need for rationalisation of cropping patterns and production of various agricultural commodities on socio-economic considerations was emphasised in a meeting of Committee of Secretaries held on 12-10-1984 as also by the Cabinet Secretariat in the context of consideration of sugar policy for 1984-85. The Prime Minister expressed his concern about rationality of existing cropping pattern and desired that the issue be examined by the Ministry of Agriculture. An Expert Group was accordingly set up to examine the socio-economic rationality of the present cropping pattern, to determine socially optimal cropping patterns for different States/regions and to suggest measures including price policy for achieving the optimum cropping pattern and production potential of different regions.

1.2 The Expert Group was initially expected to submit the report in six months but taking into consideration the quantum of analytical work involved for examining the rationality of existing cropping pattern and determination of optimum cropping pattern, its term was extended by another six months. However, the Group was asked to submit a note in advance of its report on the subject indicating its thinking on the problem. The present note* is based on a detailed discussion held in meetings of the Group in which special invitees and experts in crop production, agricultural economists and planners were present and study of a large number of technical papers published in different journals.

1.3 This note deals with existing cropping pattern and its rationality and scope for changes to make it socially optimal.

2. Existing Trends in Cropping Pattern and Growth Rates of Cropped Area

2.1 Cropping pattern refers to proportions of total cropped area allocated to different crops. The changes in cropping pattern over time would reflect the trends in crop acreage and changes in product mix. Trends in cropping pattern and growth in cropped area under different crops show the likely pattern in the supply of agricultural products in future. In order to have an idea of perspective of cropping pattern and production prospectus, trends in cropping pattern as reflected by area under different crops and their proportions to the total cropped area during the period 1950-51 to 1983-84 are shown in Table I. Growth rates of area under principal crops at all-India level during the period 1949-50 to 1983-84 and 1967-68 to 1983-84 are shown in Table II.

2.2 Table I shows that during the period 1950-51 to 1960-61, although cropped area increased by about 22 million hectares, there has not been much change in cropping pattern during this period. Percentage of area under rice and wheat together remained around 30 of the total cropped area during the period 1950-51 to 1960-61. There was a marginal increase in proportion of area under sugarcane, groundnut, cotton and pulses during this period. However, changes in cropping pattern were more marked during late sixties and seventies because of the adoption of the high yielding varieties and increased use of fertilisers and plant protection measures. The proportion of area under wheat has been showing continuous increase over time and it increased from 8.5 per cent in 1960-61 to 11 per cent in 1970-71 and 13.63 per cent in 1983-84. As against this, coarse cereals particularly jowar and bajra have been losing their relative position. It would be important to observe that the proportion of area under rice has not changed much during the period of planned development which remained around 23 per cent. Wheat has witnessed the highest compound growth rate of area of 2.67 per cent per annum as against compound growth rate of total cropped area at 0.60 per cent per annum during the period 1967-68 to 1983-84. The growth rate of area under rice was 0.64 per cent per annum which was only marginally higher than the growth rate of total cropped area. Growth rates of area under jowar, bajra, maize, barley and small millets were negative during this period.

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*This note was submitted to the Government in September, 1985.

2.3 It should be important to mention that shifts in cropped area within the foodgrain crops is quite apparent. During kharif season, shift in area has taken place from millets (jowar, bajra) to rice. Amongst rabi crops, barley and gram area which have shown negative growth rates, have been shifted to wheat crop. Although it is difficult to attribute reasons for this shift in cropped acreage, it would be relevant to mention that millets, barley and gram are grown mostly under rainfed conditions and wherever there has been extension of irrigation facilities, farmers have shown preference for crops like wheat or paddy which are high yielding and more remunerative.

2.4 As regards non-foodgrain crops, sugarcane, potato, rapeseed & mustard have shown a high rate of growth of area (1.42 per cent, 3.92 per cent and 2.02 per cent per annum respectively during the period 1967-68 to 1983-84) as compared to average growth rate of 0.50%. The proportion of area under sugarcane to total cropped area has also increased marginally from 1.29 per cent in 1950-51 to 1.77 per cent in 1983-84. Growth of area under groundnut, cotton, jute and mesta has been positive, but relatively lower than the rate of growth of area under all crops. However, on point to point basis, during the period 1980-81 to 1983-84 growth rates of groundnut and cotton area were relatively higher as compared to growth rate of area under all crops.

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2.5 As regards shift in cropping pattern due to expansion of irrigational facilities, it was observed that two-third of aditional irrigated area of about 22 million hectares (developed between 1960-61 to 1981-82) was shared by wheat and paddy together. Wheat alone occupied 47.5 per cent of the additional irrigated area as shown in Table I. Amongst non-foodgrains, principal crops which added irrigated area under them, about a million hectare each, were sugarcane, groundnut, rapeseed, mustard and cotton as also fruits and vegetables with the result that share of these crops in the total irrigated cropped area has increased over time.

3. Rationality of Existing Cropping Pattern

3.1 The question of rationality of existing cropping pattern was examined by the Group. The Group felt that farmers are quite rational in India in their choice and combination of crop enterprises. Studies have shown that farmers in India have very high levels of efficiency in combining resources and crop enterprises under the given technological possibilities and factor and product-price relationships. This fact is reflected in trends and shifts in cropping pattern which show that farmers have increased area under wheat and rice because they found that these crops are more productive and remunerative as compared to any other crop rotation/crop combination which can substitute that in any region. Pulses production is stagnating and its area is shrinking as this group of crops yields only about one-third or half of the gross income per unit of area as compared to that of other major cereals of rice and wheat. A comparative idea of average output per hectare of principal crops in India is shown in Table III. It would be seen from this Table that the value of output per hectare amongst foodgrains was about the same for wheat and rice which was highest amongst foodgrain crops. The value productivity (gross income) per hectare of jowar and bajra was barely one-thirds whereas that of gram was about half of that in wheat and rice. The value productivity per unit of area for most of the oilseed crops (except groundnut) is quite.

3.2 Value productivity per hectare of sugarcane was highest, almost five to six times of even the crops like wheat and rice. Even rice and wheat rotation together gives only about half of the total income to that of sugarcane. The choice of crops and trends in production shows that farmers are quite rational in allocating area to different crops under a given technology.

4. Price Spreads and Price Supports

4.1 In order to induce the farmers to grow a particular crop it is essential that they are assured of a fair share of the price paid by the consumers for their produce. In other words, the prices received by the farmers should reflect a substantial share of the retail prices. Table IV shows the price spread between farm harvest prices (prices received by the farmers) and retail prices. It is evident from the data given in the table that the price spread for pulses and oilseeds is very high where producers' share in the consumers price ranges only from 40 to 60 per cent as against around 80 per cent in case of rice and wheat. This shows that in spite of very high prices of pulses and oilseeds farmers are not getting their due share and large part of the consumers price is accruing to the intermediaries. There is thus need to improve marketing and price support to pulses and oilseeds so that farmers' share in the price paid by the ultimate consumers is reasonably raised.

4.2 It may further be observed that if production of oilseeds and pulses is to be raised through shifts in cropping pattern in favour of these crops, concerted efforts have to be made to bring about technological improvements, particularly varietal development to increase productivity level of these crops as higher prices cannot be a substitute for improved technology. This emphasises the potential value of programmes of technological change/development/extension for increasing production of pulses and oilseeds. Once the required technology is available, it would be easier to bring about desired shifts in cropping pattern by educating farmers through extension services.

5. Limited Land Supply

5.1 Supply of cultivable land is influenced by expansion in net area sown through reclaiming culturable waste land, and expansion in irrigation facilities, whereas total area under crops is governed by the intensity of land use as reflected by cropping intensity.

5.2 In order to develop socially optimal cropping pattern, it would be important to identify the crops which have higher demand elasticities and to which land might be reallocated. A statement showing expenditure elasticities of demand for selected agricultural commodities and their rate of growth of demand and production is annexed (Table V). It would be seen that the commodities like sugar (gur), vegetable oils and vanaspati, cotton (clothing) *etc.* have relative high elasticity of demand as compared to foodgrains which indicates that the demand for commodities like sugarcane, oilseeds and cotton is increasing at much faster rate as compared to food crops. Amongst foodgrains, elasticity of demand for pulses is higher than rice and wheat or total cereals.

5.3 With the introduction of modern technology of high yielding varieties of seed in major cereal crops, growth of production of foodgrains has increased considerably during the 70's and the early 80's. Taking into consideration the rate of growth of per capita income and elasticities of demand for selected agricultural commodities, a comparison between the rate of growth of demand and rate of growth of production was made for the period 1967-68 to 1983-84 as shown in Table V. It is observed that during this period, rate of growth of production of wheat was higher than the rate of growth of its demand whereas in case of rice production and demand grew at almost equal rates. However, the rate of growth of pulses, oilseeds and sugarcane was lagging behind the growth in their demand. A socially optimal cropping pattern should take into consideration the balances in demand and supply and more efforts should be directed towards crops, rates of growth of production of which are not keeping pace with the growth in their demand. In this context, efforts should be made to expand areas under pulses and oilseeds through diversification of cropping pattern.

6. Regional Adjustment Needs and Potential for Crop Area Extension

6.1 Since agricultural regions differ in their endowment of soil, climate, irrigation water, temperature and other natural resources, they respond differently to increased resource input and technological developments. Hence new technology does not affect or result in the same increase in marginal resource productivity in all regions. Differentials in the resource productivity in different regions/States are imporant and indicate differences in the extent of adjustment of resource prices and resource use. An idea about the variations in land productivity (average yield per hectare) for principal crops in major growing States is shown in Table VII.

6.2 It would be relevant to mention that the quantum of resources used, particularly irrigation water and fertilisers in Maharashtra for sugarcane and that of fertilisers in wheat and rice in Punjab State, needs careful examination. In fact uncontrolled use of irrigation water in Maharashtra for sugarcane has resulted in degradation of land and soil structure and development of saline and alkaline conditions. There is need to develop policy for pricing of surface water or rationing which could control its use in a more rational manner. Further, there is need to review the pricing of power and electricity to control water use and make its allocation optimal. In case of fertiliser, there is need to accord high priority to States like Madhya Pradesh, Uttar Pradesh, Bihar, Haryana, Rajasthan and West Bengal while allocating fertilisers because these States have very low level of application of fertilizer at present but have high marginal productivity for this resource.

7. Problems of Sugarcane Economy

7.1 In view of the violent fluctuations in sugarcane area and its economy, the problems of sugarcane production have received considerable attention of the planners and policy makers. There are two different regions with tropical and sub-tropical characteristics in the country which are principal sugarcane producers. The duration of the crop varies from 10 to 18 months in different regions. In view of the longer duration of crop, the physical productivity in the tropical zone, is generally higher. If has often been debated whether it would be desirable or not to plan for gradual contraction of sugarcane acreage in some parts of the country and expand it elsewhere. It has been argued that area under sugarcane in northern States of Uttar Pradesh and Bihar should be gradually decreased and devoted to production of cereals and oilseed crops whereas acreage under sugarcane in tropical zones comprising Maharashtra, Andhra Pradesh, Tamil Nadu and Karnataka should be encouraged. The Group has deliberated this issue and decided to examine it in depth while submitting the main report. However, we have examined the comparative advantages of production of sugarcane in major growing States in the country. A statement showing average physical productivity per unit of area and time as also the yield in terms of per unit of resources is given in Table VII. It would be seen from this Table that while it is true that physical productivity per unit of area is higher in tropical region comprising Maharashtra, Tamil Nadu, Andhra Pradesh *etc.* as compared to the States of sub-tropical region, this difference arises mainly because of variations in duration of crop and intensity of resource use. Yield per hectare per unit of time (when converted in terms of per annum) of sugarcane is highest in Punjab (73 tonnes) as against 64 tonnes in Maharashtra. Yield per unit of area and time for sugarcane in Uttar Pradesh is also higher than in Andhra Pradesh and is only about 15 per cent lower than in Maharashtra. However, as mentioned earlier, higher yield of 15 per cent per unit of area and time in Maharashtra could be at considerable social cost as the resources used per unit of production are many times that used in Uttar Pradesh. Fertiliser consumption in Maharashtra is six times the average fertiliser consumption per hectare in Uttar Pradesh (about 70 to 80 Kgs. as against 450 to 500 Kgs. in Maharashtra). Similarly, use of water resources in Maharashtra is five times that of Uttar Pradesh as the number of irrigation, are about 35 to 40 in Maharashtra and 8 to 10 in Uttar Pradesh.

7.2 Yield of sugarcane per unit of resource used in sub-tropical region particularly in the States of Uttar Pradesh, Punjab and Haryana is much higher as compared to the States of Maharashtra, Andhra Pradesh and Tamil Nadu in tropical region. This fact is also reflected in output-input ratios and cost of production per quintal of sugarcane. Output-input ratio is lowest in Maharashtra, indicating that cost of production of sugarcane per quintal was very high in that State. Studies conducted under the Comprehensive Scheme for Studying Cost of Cultivation/Production of Principal Crops by the Ministry of Agriculture also show that cost of production per quintal of sugarcane was much higher in Maharashtra *i.e.* about Rs. 14.71 per quintal as against Rs 9.95 per quintal in Uttar Pradesh during 1982-83

7.3 Even if we take into consideration the percentage of recovery of sugar from sugarcane, one finds that the cost of production per quintal of cane (in terms of sugar) is much lower in Uttar Pradesh as compared to that in Maharashtra.

7.4 As already discussed, sugarcane economy in sub-tropical zones is still most favourable as compared to competing crops like cereals and oilseeds. Even at the existing level of productivity of sugarcane, the total value productivity per unit of area in sugarcane is six times that of pulses and oilseeds and even a crop combination or crop rotation with 200 to 300 intensity would not be in a position to compete this crop of sugarcane. Besides, the lower value productivity of cereals, pulses and oilseeds another important factor influencing allocation of area for their production is uncertainty even at the existing level of productivity.

7.5 Pulses and oilseeds have very high degree of uncertainty because of fluctuations both in prices and yield. Since these commodities have very high degree of uncertainty regarding their income, the farmers discount the return from these crops more than the other crops and shift area in favour of crops which have relatively low degree of uncertainty. Thus, if the desired increase in production of crops like pulses and oilseeds is to be attained, the price guarantee programme for these crops will have to be made more effective and crop insurance to guarantee minimum yield should be introduced.

8. Need for Modernisation of Sugar Industry in Sub-Tropical Zone

8.1 It has been observed that Uttar Pradesh has cost advantage in the production of sugarcane as compared to States of Maharashtra, Andhra Pradesh, Tamil Nadu *etc.* Yet the cost of production of sugar in Uttar Pradesh is higher which could be attributed to various reasons. While there is minimum statutory price for sugarcane fixed by the Government of India, the prices fixed by States very considerably from State to State and sometimes they do not have any relation either with the cost of production of the State or with the recovery of sugar from cane. There is need to rationalise the prices of sugarcane fixed by States so that they bear proper relationship with the minimum statutory prices as also with the cost of production of sugarcane in the State along with sugar recovery.

8.2 Sugar industry in Uttar Pradesh needs considerable improvements both in terms of machinery and operation. The period of operation of the sugar mills in Uttar Pradesh needs thorough review so that their capacity is fully and optimally utilised and overhead cost minimised. The Group feels that the working of the sugar industry in Uttar Pradesh should be reviewed by an Expert Group in order to modernise it and improve its efficiency.

9. Conclusion

9.1 In this note we have traced the broad shifts in cropping pattern at the all-India level since 1950-51. It is proposed to carry forward this analysis to the State level somewhat in greater depth in the final report.

9.2 This preliminary analysis reveals that at the farm level farmers make their choice of crop enterprise combinations on sound economic principles. This is reflected by the fact that area of those crops which have higher value productivity per unit of area and the productivity of which in recent years has increased at a faster rate, have shown relatively higher rates of growth and have thus improved their position in the cropping pattern.

9.3 The cropping pattern which emerges at the State/National level is aggregate of area allocated to different crops by individual farmers. However, the considerations that influence the decisions of individual farmers in the choice of crops often conflict with the considerations at the national/State level. The Committee is examining all these issues and expects to combine the interests of both individual farmers and the community at large to develop economically and socially optimum cropping pattern at the national level. In its exercise the Committee is likely to take into consideration long term perspective of supply and demand balances of major agricultural commodities. It is also proposed to examine the level of fluctuations in agricultural output over time to identify areas which are most suited to different crops and study the potentials of increasing the agricultural production at the State/all-India level. Besides indicating the incentives and disincentives to achieve the desirable cropping pattern, it is also proposed to spell out the research and development requirements in depth for different crops.

9.4 Sugarcane pricing and cultivation presents a class of problems very different from other agricultural commodities. This is due to that fact that : (i) cane is not an end product but only an intermediate input, (ii) it is not a transportable commodity in as much as it degrades for processing purposes very fast after harvest, and (iii) the duration of harvesting and sugar content of cane change the cost of conversion to sugar and as these factors vary over regions, the regional profile of sugar production cost may differ for equal price of cane. Taking into consideration the cost of conversion of cane to sugar, the Committee would examine regional pricing system of cane and also the profitability of growing cane *vis-a-vis* other crops.

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TABLE I—*Cropping Pattern in India—1950-51 to 1983-84*

(Area in Thousand Hectares)

Crops	1950-51		1960-61		1970-71		1980-81		1983-84	
	Area	Per cent to total	Area	Per cent to total	Area	Per cent to total	Area	Per cent to total	Area	Per cent to total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Rice	30810	23·36	34056	22·29	37592	22·67	40152	23·16	40990	22·89
Wheat	9746	7·39	12931	8·46	18241	11·00	22279	12·85	24395	13·63
Coarse Cereals	37674	28·56	44912	29·40	45949	27·72	41780	24·10	41551	23·21
Jowar	15571	11·80	18426	12·06	17374	10·48	15809	9·12	16263	9·08
Bajra	9023	6·84	11470	7·51	12913	7·79	11657	6·72	11810	6·60
Maize	3159	2·40	4401	2·88	5852	3·53	6005	3·46	5888	3·29
Ragi	2203	1·67	2478	1·62	2472	1·49	2525	1·46	2601	1·45
Small Millets	4605	3·49	4997	3.27	4783	2·88	3976	2·29	3612	2·02
Barley	3113	2·36	3140	2·06	2555	1·54	1807	1·04	1376	0·77
Gram	7570	5·74	9274	6·07	7839	4·73	6584	3·80	7308	4·08
Tur	2181	1·65	2429	1·59	2655	1·60	2842	1·64	3175	1·77
Other Pulses	9340	7·08	11962	7·83	12040	7·26	13031	7·52	12929	7·22
Total Cereals	78230	59·32	91899	60·15	101782	61·39	104210	60·13	105936	59·73
Total Pulses	19091	14·47	23665	15·49	22534	13·59	22457	12·95	23412	13·08

TABLE I—*Cropping Pattern in India—1950-51 to 1983-84—Contd.*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Total Foodgrains	97321	73·79	115564	75·64	124316	74·98	126667	73·08	130349	72·81
Sugarcane	1707	1·29	2417	1·58	2615	1·58	2667	1·54	3166	1·77
Groundnut	4494	3·41	6467	4·23	7326	4.42	6801	3·42	7640	4·27
Castorseed	555	0·42	466	0·30	439	0·26	498	0·29	637	0·36
Sesamum	2204	1·67	1575	1.03	2433	1.47	2472	1·43	2182	1.22
Rape & Mustard	2071	1·57	1145	0·75	3323	2·00	4113	2·37	3893	2·17
Linseed	1403	1·06	1267	0·83	1897	1·14	1673	0·96	1466	0·82
Total Oilseeds	10968	8·32	12777	8·36	16644	10·04	17603	10·16	18695	10·44
Coconut	622	0·47	716	0·47	1046	0·63	1083	0·62	1155	0·65
Cotton (Lint)	3044	2·31	7610	4·98	4763	2·87	7010	4·04	7765	4·34
Jute & Mesta	571	0·43	1152	0·75	1080	0·65	1300	0·75	1029	0·57
Tobacco	357	0·27	401	0·26	447	0·27	452	0·26	440	0·25
Other Crops	17925	13·59	12851	8·41	15926	9·61	17625	10·17	17580	9·82
Total Area Sown	131893	100·00	152772	100.00	165791	100·00	173324	100·00	179024	100·00

TABLE I (a) —*All-India Cropping Pattern in Irrigated/Unirrigated Areas*

('000 hectares)

Crops	1960-61				1981-82				Distribution of additional irrigated area	
	Irrigated		Unirrigated		Irrigated		Unirrigated			
	Area	Per cent	Area	Per cent	Area	Per cent	Area	Per cent	Area	Per cent
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Rice	12523	44·7	21533	17·3	17114	33·2	23700	18·9	4591	19·43
Jowar	655	2·3	17771	14·2	623	1·2	16164	12·9	(—)27	Neg.
Maize	556	2·0	3845	3.1	1153	2·2	4770	3·8	597	2·53
Wheat	4233	15·1	8698	7·0	15467	30·0	6653	5·3	11234	47·55
Barley	1334	4·8	1806	1·4	831	1·6	904	0·7	(—) 503	Neg.
Total Cereals & Millets	20166	72·1	71733	57·5	36235	70·2	69466	55·4	16069	68·2
Gram	1107	4·0	8167	6·5	1398	2·7	6430	5·2	291	1·23
Total Pulses	1899	6·8	21766	17·4	2083	4·0	22129	17·6	184	0·78
Total Foodgrains	22065	78·9	93499	74·9	38318	74·2	91595	73·0	16253	68·80
Sugarcane	1674	6·0	743	0·6	2706	5·4	611	0·5	1092	4·62
Condiments & Spices	417	1·5	1152	0·9	735	1·4	1341	1·1	318	1·35
Total Fruits & Vegetables	477	1·7	2172	1·8	1747	3·4	3235	2·6	1270	5·38
Groundnut	195	0·7	6272	5·0	1025	2·0	6212	5·0	830	3·51
Rapeseed & Mustard	136	0·5	1007	0·8	1088	2·1	1486	1·2	950	4·02
Total Oilseeds	421	1·5	12356	9·9	2522	4·7	14797	11·8	2101	8·89
Cotton	967	3·4	6643	5·3	2204	4·3	5819	4·6	1237	5·23
Tobacco	88	0·3	313	0·3	150	0·3	297	0·2	62	0·26
Other Crops	1871	6·7	7914	6·3	3163	6·1	7741	6·2	1292	5.47
Total Area	27980	100·0	124792	100·0	51605	100·0	125430	100·0	23625	100·00

TABLE II—*Compound Growth Rates of Area, Production and Yield of Principal Crops in India*

(In per cent per annum)

Crops	During 1949-50 to 1983-84			During 1967-68 to 1983-84		
	Area	Production	Yield	Area	Production	Yield
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Rice	0·92	2·46	1·53	0·64	2·27	1·62
Wheat	2·80	6·02	3·12	2·68	5·77	3·00
Jowar	—0·16	1·37	1·53	—0·76	2·04	2·82
Bajra	0·34	2·13	1·79	—0·79	0·70	1·51
Maize	1·86	2·63	0·75	—0·05	0·66	0·78
Ragi	0·27	1·84	1·57	0·61	2·79	2·18
Small Millets	—0·77	—0·90	—0·13	—1·79	—1·23	0·57
Barley	—2·04	—0·80	1·27	—4·50	—3.01	1.54
Coarse Cereals	0.46	1·47	1·28	—0·89	0·91	1·75
Total Cereals	0·84	2·96	1·77	0·37	2·87	2·04
Gram	—0·55	Neg.	0·55	—0·38	—0·51	—0·19
Tur	0·60	0·26	—0·35	0·99	1·38	0·39
Other Pulses	0·80	0·47	—0·33	0·85	0·79	—0·06
Total Foodgrains	0·74	2·61	1·56	0.38	2·61	1·84
Total Pulses	0·13	0·23	0·08	0·47	0·35	—0·02
Sugarcane	2·04	3·11	1·12	2·02	3·05	1·01
Groundnut	1·42	1·96	0·58	0·02	1·25	1·20
Sesamum	0·05	0·46	0·41	—0·33	1·22	1·57
Rapeseed & Mustard	1·80	3·13	1·30	1·42	2·53	1·09
Seven Oilseeds-1	1·13	2·07	0·73	0·38	1·72	1·35
Total Oilseeds-2	1·06	2·00	0·62	0·32	1·53	1·13
Cotton	0·50	2·42	1·90	0·17	2·17	2·00
Jute & Mesta	0·95	1·43	0·57	0·70	2·00	1·13
Total Fibres	9·50	2·12	1·55	0·19	2·04	1·77
Tea	0·82	2·48	1·65	0·79	2·81	2·01
Coffee	2·86	4·88	1·96	3·87	4·65	0·75
Total Plantation Crops	2·34	3·12	1·72	2·21	3·33	1·85
Potato	3·99	5·97	1·90	3·92	7·42	3·37
Tobacco	0·80	2·28	1·45	0·27	2·67	2·40
Total Non-foodgrains	1·22	2·62	1·94	0·81	2·53	1·33
ALL CROPS	0·84	2·61	1·40	0·58	2·59	1·68

NOTES.—1. Seven Oilseeds include Groundnut, Sesamum, Rapeseed & Mustard, Linseed, Castorseed, Nigerseed and Saffower.
2. Total oilseeds include Seven Oilseeds, Coconut and Cotton seed.

TABLE III—*Value Productivity (Gross Income) per Hectare of Selected Crops*

(Rs. per hectares)

Crops	1970-71	1980-81	1983-84
(1)	(2)	(3)	(4)
Wheat	731·92 (100·00)	2119·00 (100·00)	2813·50 (100·00)
Rice	774·87 (105·87)	2097·50 (98·98)	2886·84 (102·61)
Jowar	209·70 (28·65)	693·00 (32·70)	910·20 (32·35)
Bajra	279·90 (38·24)	480·90 (22·69)	801·00 (28·47)
Gram	596·70 (81·52)	952·65 (44·96)	1562·40 (55·53)
Sugarcane	6223·87 (850·35)	13535·50 (638·77)	10482·00 (372·56)
Groundnut	708·90 (96·85)	1516·16 (71·55)	3001·95 (106·70)
Cotton	956·80 (130·72)	1395·36 (65·85)	1676·00 (59·57)
Jute	1269·02 (173·38)	1992·00 (94·01)	2719·50 (96·66)

NOTE.—In the absence of Farm harvest—prices of all-India level, the value productivity/hectare was estimated taking into consideration minimum support/procurement prices fixed by the Government and average yield. Figures in parenthesis show percentage to that of wheat value productivity.

TABLE IV—*Price Spread in Selected Crops in Major States*

Crop/State	Year	Farm Harvest Prices (Rs. per Qtl.)	Retail Prices (Rs. per Qtl.)	Farm Harvest Prices as percentage of Retail Prices
(1)	(2)	(3)	(4)	(5)
WHEAT				
Punjab	1983-84	152·00	189·00	80·42
Uttar Pradesh	1983-84	148·00	209·00	70·87
RICE				
Andhra Pradesh	1983-84	225·00	392·00	57·92
Tamil Nadu	1983-84	252·00	403·00	62·53
Punjab	1983-84	199·00	300·00	66·33
JOWAR				
Gujarat	1982-83	170·00	230·00	73·91
GRAM (Whole)				
Madhya Pradesh	1983-84	358·00	625·00	49·28
TUR (Split)				
Uttar Pradesh	1982-83	389·00	615·00	63·25
GROUNDNUT				
Gujarat	1982-83	433·00	569·00*	76·01
Maharashtra	1983-84	407·00	592·00*	69·00
RAPE & MUSTARD				
Uttar Pradesh	1983-84	486·00	731·00*	69·48
West Bengal	1983-84	503·00	714·00*	70·44

* In these cases retail prices are not per quintal basis but are sum total of price paid for oil and oil cake in retail produced from one quintal of oilseeds.

सत्यमेव जयते

TABLE V—*Quantity Elasticities of Demand for Selected Agricultural Commodities*, 1970-71 *and Growth Rates of Demand and Production*

Name of Item		Expenditure elasticity of demand			Growth rate of demand due to		C.G.R. of production 1967-68 to 1983-84 per cent
		Rural Population	Urban Population	Weighted Average All-India	Income Increase	Income & Population Increase	
(1)		(2)	(3)	(4)	(5)	(6)	(7)
Rice	Log-inverse	0·4133	0.1770	0·3582	0·5051	2·7451	2·27
Wheat	Do.	0·6705	0·3660	0·5995	0·8453	3·0853	5·77
Other Cereals	Do.	0·0018	(—)0·4685	(—)0·1078	(—)0·1520	2·0880	0·91
Pulses	Semi Log	0·8517	0·6642	0·8080	1·1393	3·3793	0·35
Sugar	Do.	1.6525	1·1118	1·5265	2·1524	4·3924	3·05
Gur	Do.	0·9650	0·2315	0·7940	1·1195	3·3595	3·05
Vegetable Oils	Do.	0·8825	0·9753	0·9041	1·2748	3·5148	1·53
Vanaspati	Do.	1·9757	1·4784	1·8600	2·6226	4·8626	1·53
Tea	Double Log	1·1800	1·0600	1·1520	1·6243	3·8643	2·81
Coffee	Do.	1·3900	1·5900	1·4366	2·0260	4·2660	4·65
Tobacco	Do.	0·7181	0·7923	0·7354	1·0369	3·2769	2·67
Cotton & Clothing	(Mill Made)	1·8591	1·6424	1.8086	2·5501	4·7901	2·17
Cotton & Clothing	(Hand loom)	1·5076	1·5328	1·5135	2·1340	4·3740	2·17
Cotton & Clothing	(Khadi)	1·9868	1·6977	1·9194	2·7064	4·9464	2·17

NOTE. —Population is based on 1981 census (March).

TABLE VI—*Average Yield of Selected Crops in Major States of India, 1983-84*

(Yield per Hectare in Kgs.)

State	Rice	Jowar	Wheat	Maize	Gram	Groundnut	Sugarcane	Cotton
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Andhra Pradesh	2106	557	635	1506	428	1041	68803	346
Assam	1094	—	1149	602	—	—	43882	—
Bihar	1016	—	1554	1165	736	—	30444	—
Gujarat	1396	614	2195	1493	962	886	75500	176
Haryana	2486	132	2499	1186	427	—	44254	238
Himachal Pradesh	1202	—	760	1993	—	—	—	—
Jammu & Kashmir	2066	—	1003	1034	—	—	—	—
Karnataka	1953	867	643	2818	425	886	73170	106
Kerala	1666	—	—	—	—	—	107410	—
Madhya Pradesh	970	932	1140	1385	646	716	31800	66
Maharashtra	1678	715	965	1500	425	1028	90303	75
Orissa	1157	749	1906	1020	681	1358	67657	—
Punjab	3063	—	3015	1830	594	724	61905	185
Rajasthan	1358	600	1594	1376	606	948	44205	236
Tamil Nadu	1949	783	—	2329	—	1011	92246	250
Uttar Pradesh	1264	828	1894	963	869	642	46348	112
West Bengal	1478	—	2596	1315	913	—	50365	—
ALL-INDIA	1458	734	1851	1346	651	953	55904	144

*State not important for the crop.

TABLE VII—*Physical Productivity and Economics of Sugarcane in Major Growing States of India, 1982-83*

Region/State	Yield per hectare in kgs.	Inputs per hectare					Output per hectare in Rs.					Output input ratio
		Time in months	Fertiliser in kgs.	Number of Irrigation	Irrigation charges in Rs.	Tota Cost of cultivation in Rs.		Yield/hectare per unit time of 12 months	Yield per kg. of Fertilisers	per Irrigation	o production	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
TROPICAL REGION												
Maharashtra	96256	18	459·26	36	1820	12251	13146	64171	210	2674	14·71	1·07
Andhra Pradesh	74286	18	216·23	22	1009	9904	11314	49524	344	3377	14·77	1·14
Tamil Nadu	87163	16	252·15	20	1047	9801	14252	65372	346	4358	11·38	1·45
SUB-TROPICAL REGION												
Uttar Pradesh	45654	10	70·58	7	380	4362	7952	54785	647	6522	9·95	1·82
Bihar	34231	11	30·00	7	190	4248	9032	37343	1141	4890	11·77	1·72
Punjab	60962	10	210·00	8	*	*		73154	290	7620	*	
Haryana	37415	10	124·45	7	262	4306	10562	44898	301	5345	12·87	2·46

*Recently not studied under comprehensive scheme for studying cost of cultivation/production of principal crops.